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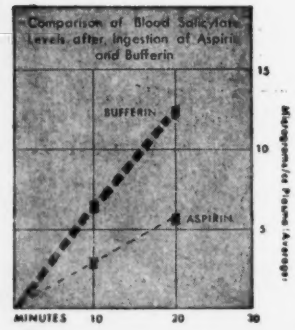

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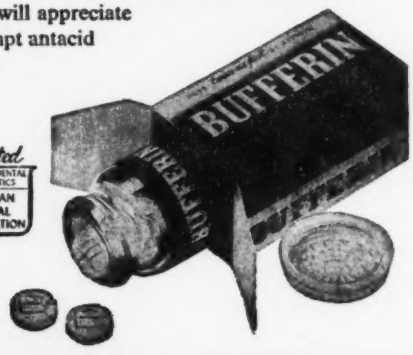

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VOLUME 12 • APRIL 1954 • NUMBER 2 JOURNAL OF ORAL SURGERY

Open reduction of mandibular fractures

■ *Robert B. Shira, D.D.S., San Francisco*

The desired result in treatment of fractures of the mandible is restoration of function of the jaws, occlusion of the teeth and normal appearance to the face. The surgeon has many methods and technical procedures at his command to obtain these results. Regardless of the method or methods employed, certain basic surgical principles must be understood and followed closely in order to insure the successful completion of treatment. Reduced to their simplest form these surgical principles include: (1) adequate reduction of the fragments, (2) adequate immobilization of the fragments, and (3) maintenance of the fragments in the immobilized position for sufficient time to allow the fractures to heal.

Adequate reduction presupposes bony contact of the fragments. The ideal reduction is one in which the normal continuity of the bone has been reestablished and the fragments are realigned in a position that is anatomically correct. If the fracture occurs within that portion of the bone containing teeth, it further implies that the teeth have been restored to normal occlusion. This ideal reduction is obtainable in a great majority of fractures; but, on occasion, because of technical difficulties, comminution, loss of substance or delayed treatment, this alignment cannot be obtained. In these instances it is good surgical judgment to accept minor discrepancies in alignment of the fragments, if they are in adequate functional position. As the fractures heal and function is restored, the process of continuous bone resorption and apposition, known as functional repositioning of bone, will correct minor discrepancies brought about by reductions that are not anatomically correct but are clinically satisfactory[1] (Fig. 1). Adequate reduction may be defined as reduction that will insure normal function of the jaws and normal appearance of the face when healing is complete.

Adequate immobilization is essential to successful healing of fractures. While untreated fractures occasionally will unite, the majority of fractures not adequately

Colonel, Dental Corps, Letterman Army Hospital.

1. Weinmann, J. P., and Sicher, H. Bone and bones. St. Louis, C. V. Mosby Co., 1947, p. 303.

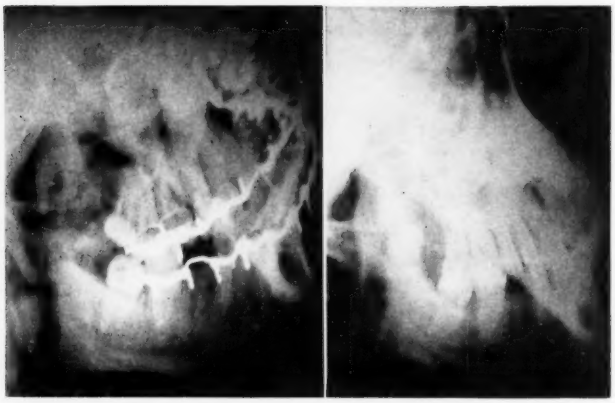


Fig. 1—Functional repositioning of bone. Left: Alignment of bone of ascending ramus after osteotomy for correction of prognathism. Right: Condition of fragments one year later. Alignment of bone has been corrected by functional repositioning

immobilized will result in nonunion. Adequate immobilization does not necessarily imply complete immobilization. Slight movement at the fracture line is desirable to stimulate the formation of granulation tissue which is an essential step in bone healing. It has been shown that fractures so firmly immobilized that all movement is eliminated will result in nonunion. Although this undoubtedly is true, the movement must be so slight that it cannot be detected clinically for gross movement will result in nonunion. Immobilization, therefore, must be such that it allows no discernible movement of the fragments. Fragments so immobilized still will have sufficient movement to stimulate osteogenesis.

After adequate reduction and immobilization, the fragments must be maintained in the desired position for sufficient time to allow complete healing. No definite time can be allocated for healing since many variable factors enter into the problem. Simple fractures heal in a relatively short time, while badly comminuted fractures require treatment for longer periods. Associated conditions such as infection, age, systemic diseases, nutrition, and so on, influence the rate of fracture healing. Since bone healing takes place some time before it is demonstrable in roentgenograms, the surgeon must be guided by clinical signs of union in determining the length of time that immobilization is necessary.

While the afore-mentioned surgical principles are relatively simple, at times many technical difficulties are encountered in fulfilling their requirements. No fixation appliance or method of immobilization should be considered adequate unless it completely fulfills these basic requirements. The majority of mandibular fractures can be treated successfully by the simpler methods of intermaxillary fixation. It is safe to say that the simplest method of treatment is the best method if it will obtain the desired results. Complicated splints, extraoral fixation, open reduction, and so forth, are to be avoided if simpler methods of reduction and immobilization will suffice. On occasion, however, simple methods will not

achieve adequate reduction and immobilization, and the surgeon will be forced to resort to other, more complicated methods. Surgeons, because of differences in training and experience, prefer some types of treatment over others and it probably matters little what method is used as long as the desired results of restoration of function, occlusion and normal appearance are obtained. Many methods are available for treating these complicated fractures, all of which have advantages and disadvantages. Various wiring technics, splints, extraoral skeletal fixation, intraoral skeletal fixation, horizontal pin fixation, circumferential wiring, open reduction with direct interosseous wiring, bone plates, and so on, all have been used with varying success. This discussion will be concerned primarily with open reduction and direct interosseous wiring, although brief mention of other methods of immobilization that utilize an open approach will be mentioned. Treatment of condylar fractures is not within the scope of this discussion.

■ *Open Reduction and Interosseous Wiring*

Open reduction and direct interosseous wiring of fragments is not a new procedure. It has been used for many years, but prior to the days of chemotherapy and antibiotics its use so often was followed by postoperative infection, necrosis, osteomyelitis, sequestration and nonunion, that it was largely abandoned.[2] With the advent of the anti-infective agents, it became possible to use surgical procedures that were previously considered dangerous. Intraoral contamination of the wound, which was once considered synonymous with infection, is now considered merely a slight complicating factor. The introduction of tantalum, Vitallium, stainless steel and other noncorrosive materials furnished inert substances suitable for direct application to bone fragments. Thus, open reduction, through either an intraoral or extraoral approach has become an important adjunct in the treatment of the more complicated mandibular fractures. Surgeons are turning more and more to this procedure when intermaxillary fixation is inadequate.

ADVANTAGES AND DISADVANTAGES OF OPEN REDUCTION—Open reduction and direct interosseous wiring is probably the most accurate method of securing reduction and immobilization of the fragments. It permits direct visualization of the fracture site, and even grossly displaced fragments can be returned rapidly to proper position and maintained with a minimum of trouble. The operative procedure is relatively short, and the accurate reduction of the fragments with intimate bony contact undoubtedly hastens bony consolidation. Once the fragments are reduced and the wound closed, the patient is comfortable. The method is simple to apply and many times eliminates the necessity of bulky head caps and external traction appliances that are uncomfortable and distasteful to the patient.

The disadvantages are few. Open reduction from an extraoral approach, of necessity, leaves a scar in the overlying skin. This cosmetic defect can be mini-

2. Waldron, C. W. Fractures of the mandible with special reference to reduction of complicated displacements and subsequent immobilization. Journal-Lancet 62:228 June 1942.

mized by accurate placement of the incision below the mandible and utilization of accepted plastic procedures for skin closure. The method requires hospitalization of the patient, the use of an operating room, additional personnel and the knowledge of accepted aseptic surgical technic. It requires surgical training beyond that needed for intraoral dentoalveolar surgery and should not be attempted unless the operator is well versed in surgical procedures. The surgeon must possess a thorough knowledge of the surgical anatomy of the region. On rare occasions, because of improper surgical technic, the mandibular branch of the facial nerve may be severed. This extremely unfortunate accident results in permanent paralysis of the muscles of the corner of the mouth, and great care should be exercised to avoid this structure. Careful surgical technic, combined with a thorough knowledge of the surgical anatomy of the mandibular and submandibular regions, should circumvent this hazard. The incidence of infection, osteomyelitis and necrosis has been largely overcome by antibiotic therapy and needs to be given little consideration.

INDICATIONS AND CONTRAINDICATIONS FOR OPEN REDUCTION—There are several situations in which open reduction and direct interosseous wiring may be considered the method of choice:

1. In fractures occurring at the angle or distal to the teeth where adequate reduction cannot be obtained or maintained by simpler means, open reduction quickly and accurately solves the problem (Fig. 2).

2. In edentulous mandibles where there is gross displacement of the fragments, open reduction is an ideal method for restoring the desired continuity of bone (Fig. 3).

3. In mandibular fractures when the maxilla is edentulous or contains insufficient teeth to allow intermaxillary wiring, open reduction is an excellent method of treatment (Fig. 4).

4. In cases where treatment has been delayed for various reasons or soft tissue has become interposed between the fragments, open reduction affords the best method of accurately freshening the bone ends and correcting the malposition.

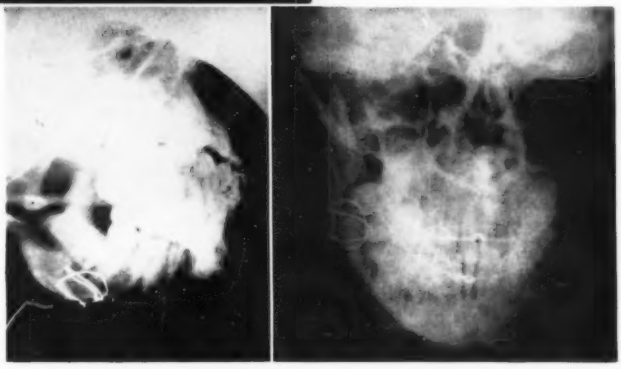
5. In multiple fractures of the facial bones it often is necessary to establish a "base of operations" to determine the normal occlusion and form a foundation for application of traction to other fragments. Direct visualization and wiring of the mandibular fragments permit rapid restoration of the continuity of the bone and make the bone available as a base for restoration of the position of maxillary fragments.

6. In instances where nonunion has resulted after other methods of treatment, this method surpasses all others for it permits direct visualization of the fracture site and allows proper freeing, freshening and impaction of the fragments.

7. In instances where malunion has resulted from lack of treatment or from inadequate treatment, open reduction affords access to the fracture site and permits reconstruction of the fracture and correction of the deformity.

8. In cases where there has been extensive loss of osseous substance because of trauma, infection or neoplasia, open

Fig. 2—Left: Fracture through angle with lateral and superior displacement of proximal fragment



Right: Position of fragments after open reduction and interosseous wiring. Intermaxillary fixation also was utilized

reduction and interosseous wiring forms an excellent means of stabilizing bone grafts (Fig. 5).

9. In fractures in young children, where displacement of fragments sometimes is difficult to control, open reduction and direct wiring of the fragments offers the means of coping with the situation in properly selected cases (Fig. 6).

There are few contraindications for open reduction. The method should not be used if the fragments can be reduced and maintained in satisfactory position and alignment by simpler means which do not require the surgical exposure of bone. Sanford Moose coined the phrase "surgical exercise" to describe instances where surgery is performed without clear-cut indications for the procedure. Treatment of fractures by open reduction when some method of intermaxillary fixation would produce the same result fits into this category. Open reduction is contraindicated in comminuted fractures that present multiple small fragments of bone where stripping the periosteum would jeopardize the vitality of the fragments (Fig. 7). Patients who are poor surgical risks because of systemic disorders or debilitating diseases probably should not be subjected to the surgical procedures necessary to carry out open reductions. The cosmetic defect of the scars in the submaxillary region

Fig. 3—Left: Bilateral fractures of edentulous mandible with moderate displacement of fragments. Right: Position of fragments after open reduction and direct interosseous wiring

also should be given consideration. Intraoral contamination of the wound, which was once thought to be a definite contraindication, is no longer a deterring factor.

OPERATIVE PROCEDURE—The majority of open reductions are performed through an extraoral approach and should be done in an operating room where correct aseptic surgical technic can be maintained. General anesthesia usually is preferred, although the procedure may be carried out under a local anesthetic without difficulty. After the field has been prepared and draped, an incision is made approximately 1 cm. below the lower border of the mandible. The incision should be placed sufficiently low to avoid the mandibular branch of the facial nerve. The length of the incision depends on the extent of the fracture line, but should be sufficiently long to permit adequate retraction of soft tissue for liberal exposure of the fracture site. The initial incision is carried through the skin and superficial fascia to the platysma muscle. The platysma is carefully sectioned, and constant vigilance is maintained for the mandibular branch of the facial nerve which is located just deep to the platysma at the inferior border of the mandible. The flap is developed superiorly carrying this nerve in its substance.

If the operative site is in the molar region, the external maxillary artery and anterior facial vein are identified, clamped, cut and ligated. In other regions, exposure of the fracture site is possible without disturbance of these structures. The inferior border of the mandible should now be in view, and the periosteum is cut by sharp incision and reflected by periosteal elevators. The ends of the fragments are located, and all soft tissue and debris are removed from the fracture line. When treatment has been delayed, the ends of

the bone are freshened. Sufficient exposure is obtained to permit the grasping of the fragments with bone-holding, or Kocher's forceps. The fragments then are manipulated and returned to their proper position while the location for the drill holes is determined.

The holes are placed as near the inferior border of the mandible as practical and approximately 0.5 cm. from the fracture line. Two holes are drilled in each fragment and 0.016 or 0.025 inch stainless steel wire is passed through the prepared holes on either side of the fracture line. Two wires are used which cross each other diagonally. The two wires afford better stabilization and more adequately resist the forces which tend to displace the fragments. The fragments are held in the reduced position while the wires are tightened.

The wound is closed in layers, the periosteum and subcutaneous tissue by no. 00 catgut sutures and the skin by interrupted no. 0000 silk sutures or subcuticular wire suture. External pressure dressings are applied and are maintained firmly by means of an Ace bandage or Elastoplast. If there are no complications, the dressings and sutures should be removed by the sixth or seventh day.

The direct interosseous wiring should not be relied on for complete immobilization of the fragments, and some supplemental method of fixation should be employed. Although the placing of inter-

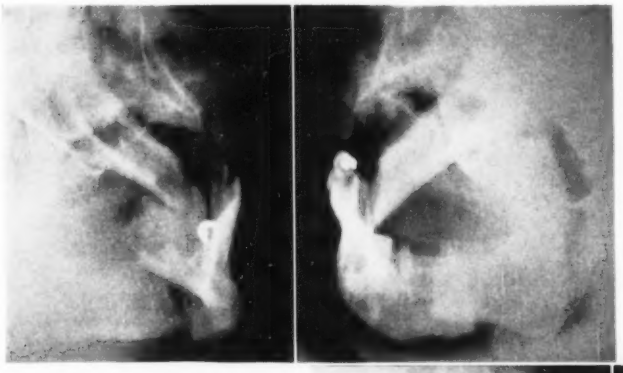
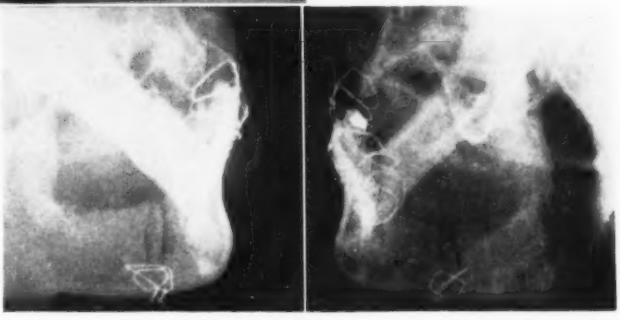


Fig. 4—Left: Bilateral fracture of mandible with edentulous maxilla



Right: Fractures have been reduced by open reduction and direct interosseous wiring. Supplemental immobilization secured by intermaxillary wiring between natural lower teeth and maxillary denture

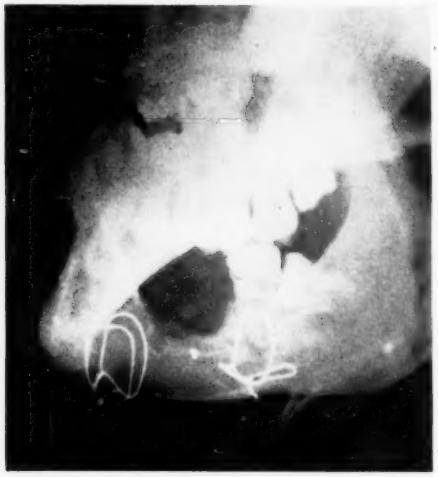


Fig. 5—Bone graft to replace extensive loss of substance of mandible after trauma. Direct interosseous wiring was used to stabilize bone graft in position. Mandible immobilized by intermaxillary wiring

osseous wires insures contact of the fragments, these wires are not capable of completely immobilizing the fragments if unrestricted use of the jaws is allowed. Particularly in bilateral fractures of the body of an edentulous mandible is supplemental immobilization important. Because of the elevator effect of the masseter, internal pterygoid and temporal muscles on the two proximal fragments and the depressor effect of the suprahyoid muscles on the distal fragment, movement and displacement of the fragments may be expected in spite of the interosseous wiring (Fig. 8, above). Intermaxillary wiring or elastic traction may be employed for this supplemental immobilization when teeth are present in both arches. With an edentulous maxilla but with teeth in the mandible, fixation of the mandibular teeth to the maxillary denture or a maxillary splint may be used (Fig. 8, below). In completely edentulous patients, Gunning's splints or the patient's dentures may be utilized and elastic traction from a chin cup to a head cap used to maintain the

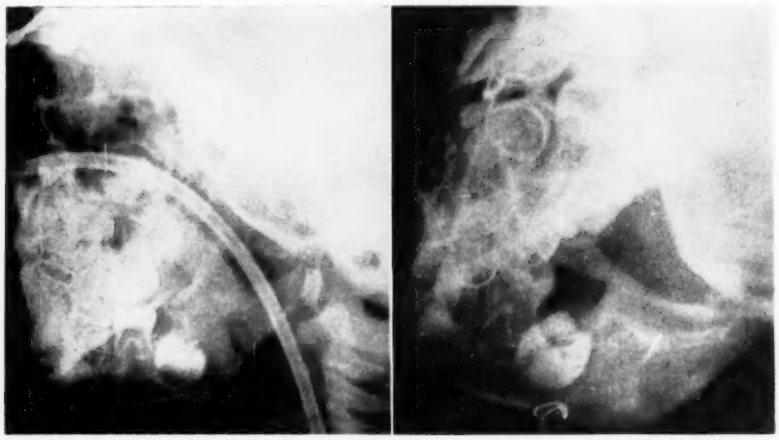


Fig. 6—Fracture of mandible of young child. Left: Displacement still present after several attempts to reduce and immobilize displaced fracture by conservative methods. Right: Displacement corrected by open reduction. Only one wire used because of thinness of mandible

fragments in the splint. In rare instances it may be necessary to pass a Kirschner wire through the symphysis and fasten it to some head appliance to obtain the desired immobilization (Fig. 9).

INTRAORAL EXPOSURE FOR INTEROSSEOUS WIRING—Intraoral exposure and fixation of fragments has become a popular adjunct to the method of open reduction in the past few years. No longer is the fear of serious infection of soft tissue and bone a deterring factor, and excellent results have been obtained in selected cases. On occasion it is necessary to remove a tooth from a badly displaced fragment, and while the region is exposed it is simple to drill a small hole in each fragment and place an interosseous wire to maintain the fragment in correct position. This simple procedure often eliminates the necessity for subsequent extraoral open reduction. The fracture lines often are so placed that it is possible to pass the wire through only the buccal cortical plate to insure reduction (Fig. 10). If the fracture lines are not favorable, or displacement is minimal, the wire may be passed through the full thickness of the bone. Fractures of edentulous segments of the body can be handled nicely by this method (Fig. 11). Exposure is relatively simple, drilling of the holes may be accomplished with a hand drill or burs in a handpiece, and placement of the wires affords excellent reduction. The mucous membrane heals readily over the wires and the procedure is scarcely more traumatic than extensive dentoalveolar surgery.

As in extraoral open reduction, supplemental intermaxillary immobilization

Fig. 7—Badly comminuted fracture of mandible. Open reduction is contraindicated because of severe comminution

is indicated with this method, for it is unwise to depend on the interosseous wires for complete immobilization.

Wires placed through an intraoral approach usually require removal after the bone has healed. Their position relatively high on the alveolar ridge sometimes causes irritation or interferes with a subsequent prosthesis, and since their removal is a minor procedure, it is definitely indicated. Wires placed through an extraoral approach seldom cause difficulty and are rarely removed. If, because of irritation, interference with prosthesis or for any other reason, their removal is indicated, they may be removed intraorally rather than by reopening the external incision.

There are definite advantages to the intraoral method of interosseous wiring. It obviates the necessity for an extraoral incision with subsequent scarring and possibility of injury to the facial nerve. It is less time-consuming and often can be done in the office under local anesthesia. For fractures in the body and symphysis which require direct interosseous wiring

to insure adequate reduction, the method should be given serious consideration.

■ *Bone Plates*

There are various types of bone plates for reduction and immobilization of mandibular fractures. These plates, made of inert metal, are applied directly to the bone, usually through an extraoral approach, and are fastened to the fragments by one or two screws on either side of the fracture line. There are few indications for this method of treatment as the desired results usually may be obtained by simpler means. The indications generally are limited to oblique fractures of the edentulous mandible that have a tendency to override, or to cases where loss of sub-

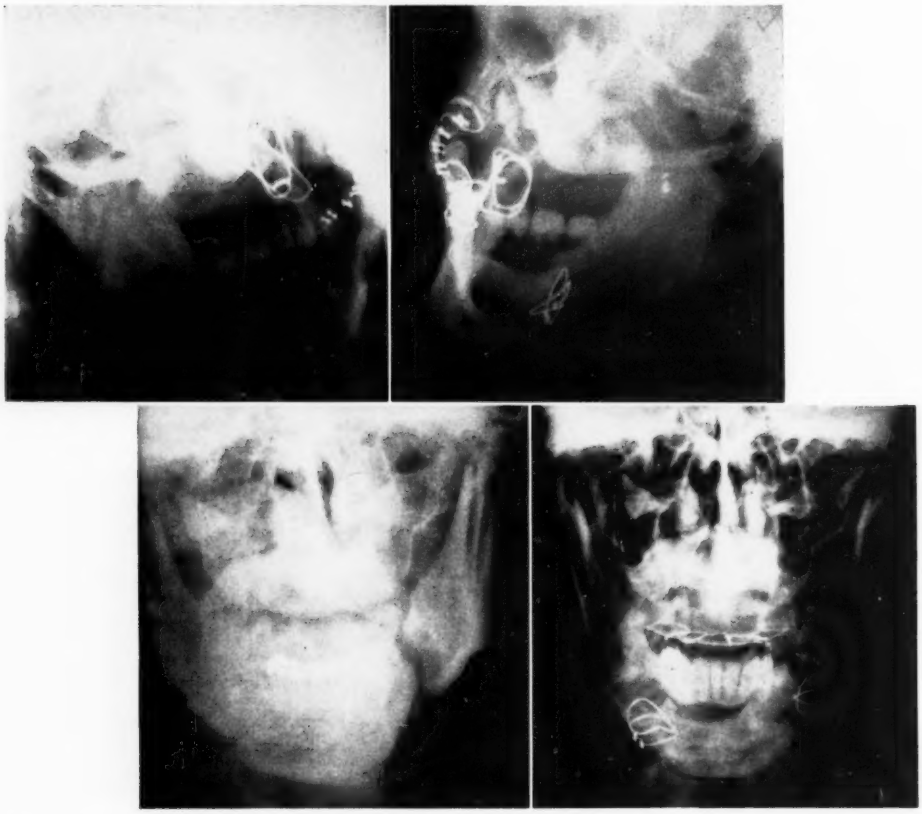


Fig. 8—Above: Type of displacement to be expected from muscular pull in bilateral fractures of body of edentulous mandible. Although supplemental intermaxillary fixation was used in this case, displacement of fragments occurred when patient received additional trauma to the mandible. Displacement probably was due to muscular pull on the fragments. Below: Supplemental immobilization secured by intermaxillary wiring between natural mandibular teeth and maxillary acrylic splint. Left: Preoperative view. Right: Postoperative view

stance, malunion or nonunion has resulted from other methods of treatment (Fig. 12).

There are theoretical disadvantages to the use of bone plates. Eggers, Shindler and Pomerat[4] have shown in artificially produced fractures in skulls of rats that union occurred more rapidly if a slight compressive force was maintained across the fracture line. Union was delayed and sometimes absent when this contact compression factor was absent. Eggers, Ainsworth, Shindler and Pomerat[5] state that any rigid fracture fixation device which deprives the region treated of the contact compression factor denies the part of a necessary and useful physiological influence and is conducive to nonunion. Bone plates rigidly fastened across a fracture line may well interfere with this compression factor and because of this interference contribute to delayed union or to nonunion.

Healing of fractures is not only a process of ossification of the connective tissue between the fragments but includes a more or less extensive resorption of the opposing ends of the fragments.[6] While resorption and osteogenesis probably occur simultaneously, there is the possibility that a space may develop between the fragments when they are rigidly fixed by means of bone plates. Delayed union or nonunion would be the result if these conditions were present.

Another disadvantage of plating is the lack of contact of the periosteum with the bone in the involved region. Plates are bulky and by their intimate contact with bone obviate the possibility of the periosteum being replaced in the regions occupied by the plates. This may be a deterring factor to osteogenesis and may lead to delayed healing.

Fig. 9—Immobilization of mandible as supplement to direct interosseous wiring. Kirschner wire extends through symphysis and is fastened to head cap by means of rigid metal bars

Plates used on small atrophic mandibles may, because of their bulk, cause irritation either intraorally or extraorally and it may be necessary to remove them after complete bony regeneration.

Bone plates are of some value when there is extensive loss of bone or when revision of the bone ends is required after malunion or nonunion. The plates may be used to maintain fragments in the desired position while the defect is replaced by bone chips or solid bone graft.

As in other methods of direct osseous reduction, bone plating should be aug

3. Thoma, K. Oral surgery, vol. 1, ed. 2. St. Louis, C. V. Mosby Co., 1952, p. 585.

4. Eggers, G. W. N.; Schindler, T. O., and Pomerat, C. M. Influence of the contact-compression factor on osteogenesis in surgical fractures. J. Bone & Joint Surg. 31A:693 Oct. 1949.

5. Eggers, G. W. N., and others. Clinical significance of contact-compression factor in bone surg. Arch. Surg. 62:467 April 1951.

6. Weinmann, J. P., and Sicher, H. Bone and bones. St. Louis, C. V. Mosby Co., 1947, p. 299.

mented by some method of supplemental fixation.[3] The bone plates adequately reduce the fragments but should not be relied on for complete immobilization. Torque and strains are apt to develop which, if not controlled, will result in failure.

■ *Internal Pin Fixation*

Another method of direct osseous reduction of mandibular fragments worthy of mention is internal pin fixation. It consists of drilling a Kirschner type wire, generally 0.05 or 0.08 inch in diameter, longitudinally through one fragment and across the fragment line into the adjoining fragment. The method has been popularized by Brown and McDowell[7-9]

7. Brown, J. B., and McDowell, F. Internal wire fixation of fractures of jaw; preliminary report. Surg. Gynec. & Obst. 74:227 Feb. 1942.

8. Brown, J. B., and McDowell, F. Internal wire fixation of jaw fractures with note on external bar fixation. Surg. Gynec. & Obst. 75:368 Sept. 1942.

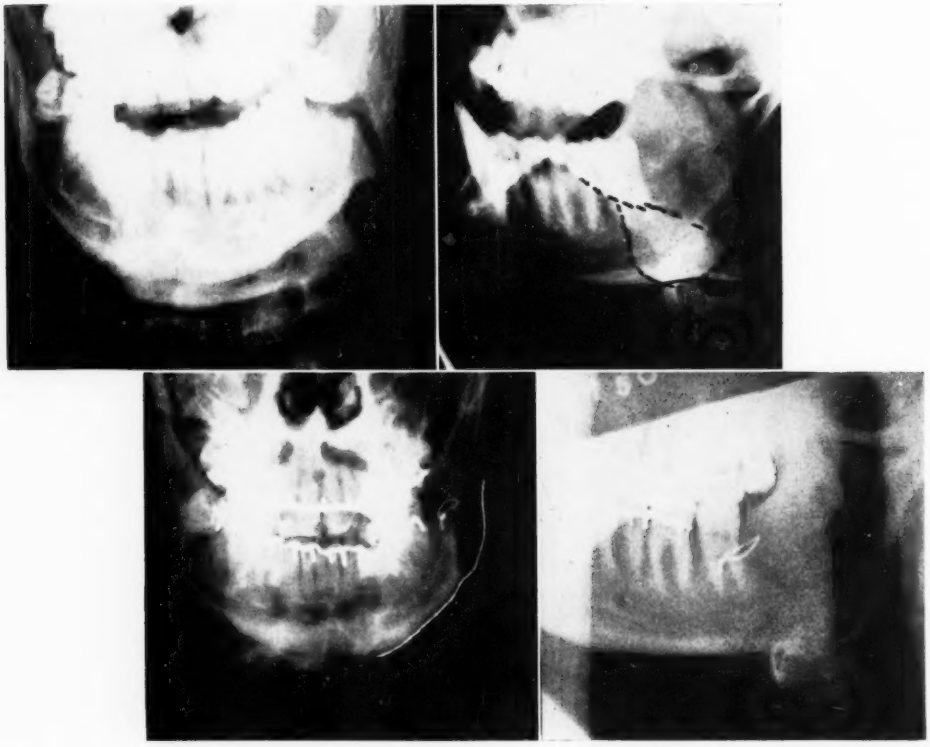


Fig. 10—Fracture of angle with displacement of proximal fragment. Treatment was delayed because of associated head injuries. Third molar in line of fracture was removed and while region was exposed, a single interosseous wire was passed through buccal cortical plate of bone. Wire held displaced fragment in good position. Above: Preoperative view. Below: Postoperative view

and Pincock[10] in this country and by Ipsen[11], Meade[12] and Soybe[13] in Europe. These authors claim many indications and advantages for the method, and in properly selected cases it affords a valuable adjunct to the armamentarium of the surgeon.

By the technics described, the wires are drilled into the bone through small stab wounds in the skin, thus direct exposure of the fracture lines is unnecessary. In some technics the wires are allowed to extend beyond the margins of the bone through the skin, while in others the wires are cut short at the bone margins and the skin is closed over the wire.

The technical difficulties involved in the correction of displacement and the holding of the fragments in alignment during the insertion of the wire are considerable. The overcoming of these difficulties requires great surgical skill. The thinness and curvature of the mandible, the absence of cancellous bone in the region of the angle and the size and location of the inferior alveolar structures in the bone are complicating factors.[14]

The possibility of infection gaining entrance to the cancellous bone along the wire is a distinct possibility but usually can be controlled by present-day methods. Internal wire fixation permits immobilization in only one plane, the vertical, but allows rotation on an axis; also, it may allow the fragments to pull apart.[14] Rotation may be controlled by use of splints or interdental wiring, while the tendency of the fragments to pull apart may be controlled by providing a mechanical "stop" at the margins where the wire enters and leaves the bone.

The method as advocated allows mandibular function with resultant comfort to the patient and improved oral hygiene. Intermaxillary fixation is considered unnecessary and there are no cumbersome extraoral fixation appliances to annoy the patient.

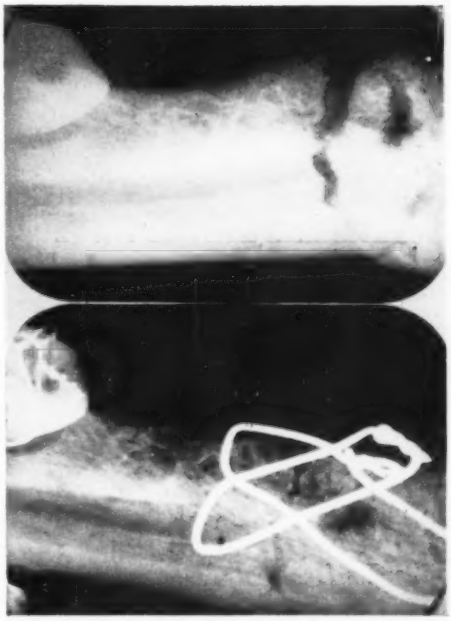


Fig. 11—Intraoral open reduction in fracture of edentulous segments. Above: Preoperative roentgenogram showing moderate displacement of fragments. Below: Displacement corrected by interosseous wiring placed through intraoral approach

9. Brown, J. B., and McDowell, F. Internal wire fixation of fractures of jaw. Am. J. Orthodont. & Oral Surg. (Oral Surg. Sect.) 29:86 Feb. 1943.

10. Pincock, D. F. Horizontal pin fixation for fractures of mandible using pin guide. Surg. Gynec. & Obst. 77:493 Nov. 1943.

11. Ipsen, John. Eine Behandlung von Kieferbruchen. Zentralbl. f. Chir. 60:2840 Dec. 9, 1933.

12. Meade, H. New method for treatment of fracture of lower jaw. Irish J. M. Sc. July 1935, p. 318.

13. Soybe, Paul. Treatment of fractures of the corpus mandibulae ad modum Ipsen. Act. Chir. Scandinav. 83:445, 1939.

14. Waldron, C. W.; Kazanjian, V. H., and Parker, D. B. Skeletal fixation in treatment of fractures of the mandible. J. Oral Surg. 1:59 Jan. 1943.

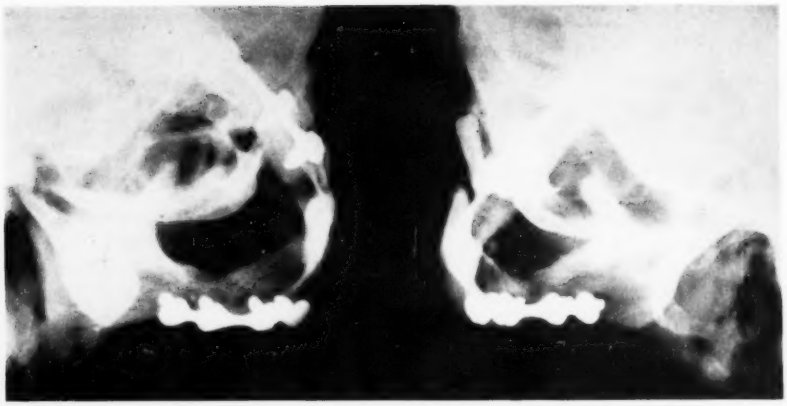


Fig. 12—Bilateral bone plates used in treatment of fractures of edentulous mandible. This case had been treated previously by direct interosseous wiring (Fig. 8, above). Because of additional trauma and displacement, nonunion had resulted. Excellent results obtained when bone plates were applied

Although this method has produced excellent results in skilled hands, comparable results may be obtained in the majority of instances with less complicated methods, and its use should be reserved for carefully selected cases and for surgeons thoroughly trained in the proper utilization of the technic.

The method may be used to advantage when supplemental immobilization of the mandible presents a problem. A wire drilled through the symphysis with the end extending some distance through the skin on either side can be attached to a head appliance by elastic traction or rigid metal rods to secure firm immobilization (Fig. 13).

■ *External Skeletal Pin Fixation*

Although external skeletal pin fixation is not a procedure that properly would be considered under the topic of open reduction, its use does imply interosseous placement of fixation appliances, so it will be discussed briefly. An excellent review of the subject was published by Waldron, Kazanjian and Parker[14] in 1943 and little can be added to their discussion and conclusions. The procedure has been tried almost universally by oral surgeons, some of them becoming enthusiastic about its use and others, because of failures, discarding the technic. Various types of appliances are available, and variations in technic of application have been developed which render the fixation appliances extremely adaptable. In skilled hands, excellent results have been obtained by its use. On the other hand, probably no other single procedure used in the treatment of mandibular fractures has been so abused.

The indications for use of skeletal fixation are essentially the same as for open reduction (Fig. 14). Whether open reduction or skeletal fixation should be used in any particular case depends largely on the training, experience, judgment and

Fig. 13—Kirschner wire passed through symphysis and attached to head appliance. This affords excellent supplemental immobilization for mandible

skill of the surgeon. Either method, when properly selected and applied will assure satisfactory results.

Certain advantages are to be expected by the use of skeletal fixation. It permits early application, freedom of movement of the mandible, better oral hygiene, maintenance of a normal diet, no impediment of speech, minimal scarring of the face and no foreign body contacting or crossing a fracture line.[15]

In the past the use of skeletal pin fixation has been complicated on occasion by infection, loosening of the pins and inadequate immobilization of the fragments. These disadvantages have been largely overcome by antibiotic therapy, improved pins and improved surgical tech-

15. Bourgovne, J. R. Fractures: open reduction vs. skeletal fixation. Am. J. Orthodont. & Oral Surg. (Oral Surg. Sect.) 31:519 Aug. 1945.

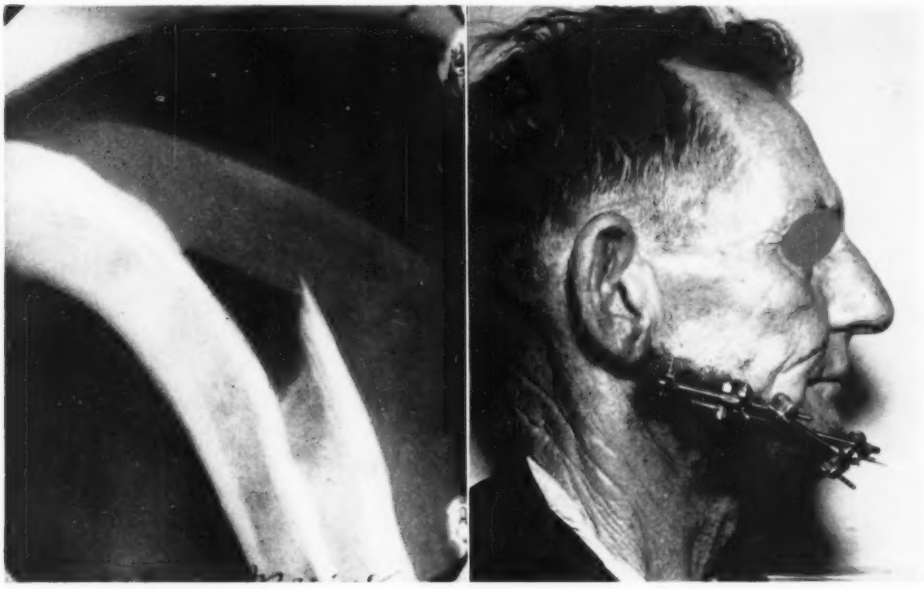


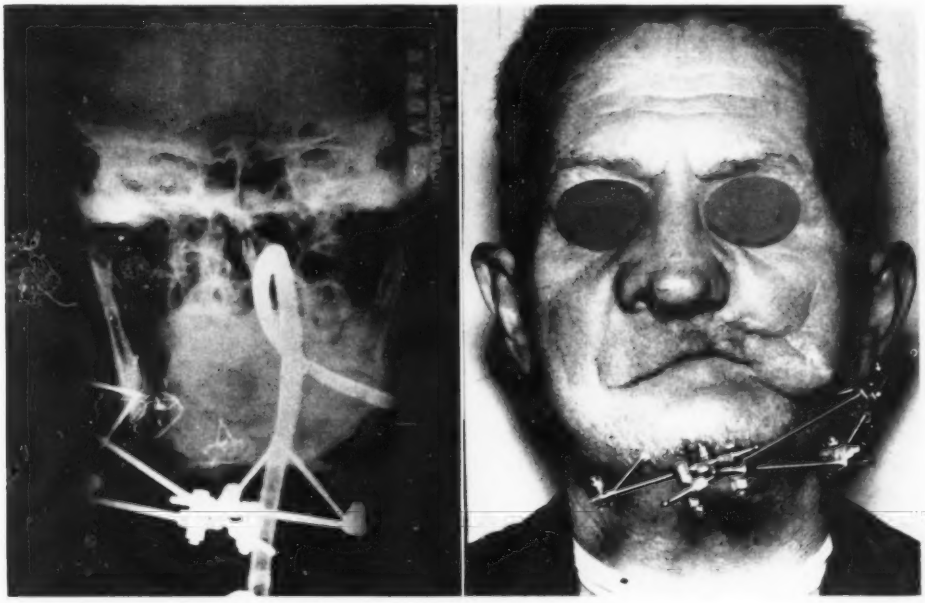
Fig. 14—Extraoral skeletal fixation for treatment of fracture of edentulous mandible. Left: Occlusal roentgenogram showing displacement of fragments. Right: Extraoral skeletal fixation appliance in place

nic. Although the pins are inserted into bone through small incisions in the overlying tissue, the method of reduction is obviously a closed one as direct visualization of the fracture line is not possible. Adequate reduction must be determined by palpation, observation of occlusion and facial symmetry and postoperative roentgenograms. Obviously inadequate reductions must be corrected by subsequent manipulation and adjustment of the appliance. The fixation appliances are bulky and somewhat unsightly and occasionally are annoying to the patient.

Skeletal fixation is invaluable in certain instances. In the removal of pathological lesions where large parts of the mandible are involved and where the continuity of the bone is in jeopardy, the preoperative application of skeletal fixation appliances should be given serious consideration. The appliance may prevent pathological fractures or, if fractures do occur, it will prevent displacement of the fragments (Fig. 15). In cases where there has been extensive loss of substance of the mandible from various causes and bone grafts are required to restore osseous tissue, skeletal fixation is a valuable method of maintaining the segments in proper position while healing is progressing (Fig. 16). Skeletal fixation is also valuable in cases where intermaxillary fixation is contraindicated because of prolonged nausea or the necessity of transporting patients great distances by sea or air.

Fig. 15—Extraoral skeletal fixation appliance utilized to prevent fracture of mandible when large pathologic area was removed. Left: Preoperative application of extraoral skeletal appliance. Right: Postoperative roentgenogram showing large operative defect and skeletal fixation appliance in place

Fig. 16—Skeletal fixation used in conjunction with bone graft to mandible. Left: Roentgenogram showing skeletal fixation appliance stabilizing fragments. Right: Extraoral skeletal fixation appliance in place



■ *Conclusion*

Open reduction in treatment of mandibular fractures affords the surgeon a positive, sure, rapid and accurate method of reduction. Although there are several clear-cut indications for its use, it should be employed only when accepted methods of intermaxillary fixation will not produce the desired results.

Regardless of the method or methods used, the surgeon should be constantly alert to see that the treatment assures adequate reduction and immobilization for a sufficient time to allow bony consolidation. There is no method of treatment of mandibular fractures that does not have its disadvantages, and the surgeon should select the method that works best in his hands, one that affords maximum comfort to the patient and permits restoration of occlusion of the teeth, function to the jaws and normal appearance to the face.

Treatment of condylar fractures

■ *Kurt H. Thoma, D.M.D., Brookline, Mass.*

Condylar fractures vary in regard to location of the fracture and the position of the fragments. Since normal mandibular motion depends on the proper function of both joints, it is of great importance to determine whether a fracture is unilateral or bilateral. In bilateral fractures restoration of the original anatomical position of the fragments is essential if free range of jaw motion is the objective. In unilateral fractures the uninjured condyle helps to maintain the relative position of the jaw. In bilateral fractures the rami are pulled up by the elevator muscles, and the mandible is completely displaced. This condition causes occlusal derangement and resultant disfigurement because of mandibular retrusion and displacement of the fragments. If the patient has no molar teeth, the displacement is greater both in regard to the position of the jaw and in regard to condylar fragments, since occlusal support is lacking (Fig. 1) and posterior vertical dimension has been lost.

■ *Location of Fracture*

Most fractures are located in the neck of the condyloid process, but in rare instances they involve only the head of the condyloid process. The former are extracapsular fractures, while the latter are generally intracapsular. The fracture may occur in a frontal or sagittal plane, and part of the head of the condyloid process may remain attached to the jaw. The extent of displacement of the fractured head of the condyloid process will depend on the nature and the force of the trauma, the size of the capsular tear and the relation—attachment or separation—of the external pterygoid muscle to the displaced fragment.

Subcondylar fractures are differentiated by the fact that they occur in the base of the condyle and therefore may extend into the ramus itself (Fig. 2).

■ *Position of Fragments*

In order to determine the position of the fragments, both posteroanterior and lateral roentgenograms of the temporomandibular joint are needed. Classified according to the position of the fragments, fractures are divided into four types: (1) fracture without displacement, (2) fracture with displacement, (3) fracture-dislocation, (4) fracture-dislocation with complete displacement of the condyle.

FRACTURE WITHOUT DISPLACEMENT—Fractures without displacement are the so-called greenstick fractures or complete fractures with the fragments remaining in their anatomic position.

FRACTURE WITH DISPLACEMENT—Fractures with displacement are quite common. In the lateral view, forward and backward displacement can be recognized;

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in the posteroanterior view (Fig. 3, left) and in the lateral view (Fig. 3, center), location of the condylar fragment can be determined. Generally there is considerable overriding, particularly if there is no occlusal support. Overriding is aggravated also by muscular trismus, especially of the masseter, temporal and internal pterygoid muscles. Anterior and medial displacement is caused by the pull of the external pterygoid muscle.

FRACTURE-DISLOCATION—A fracture-dislocation may or may not show separation of the fracture ends; the principal feature is that the head of the condyloid process is dislodged from the glenoid fossa. Medial dislocation is more likely because of anatomical conditions, but occasionally lateral dislocation occurs. In both types of fracture-dislocation, the condyle penetrates the ruptured capsule. The posteroanterior view shows a fracture-dislocation most clearly (Fig. 3, right); 45 degrees to 90 degrees of angulation is not uncommon. Posterior or anterior dislocation is generally intracapsular and may include only a portion of the head of the condyloid process, which may or may not be comminuted. Comminution is more common in gunshot fractures.[1]

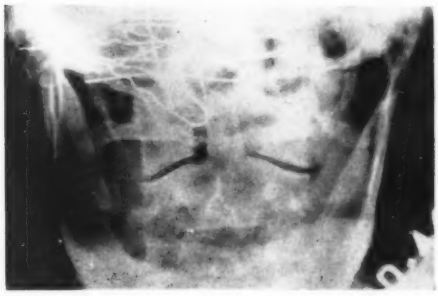


Fig. 1—Unilateral fracture and displacement of condyle in edentulous jaw which has no occlusal support

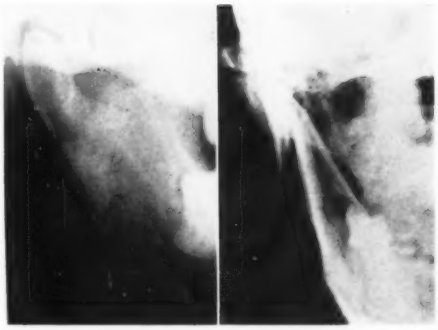


Fig. 2—Left: Subcondylar fracture, lateral view. Right: Subcondylar fracture, posteroanterior view

FRACTURE-DISLOCATION WITH COMPLETE DISPLACEMENT OF THE CONDYLE—A fracture-dislocation with complete displacement of the condyle presents a difficult surgical problem because such a fracture involves not merely an angulation of the articular head but complete separation from the main fragments. Since the displacement of the dislocated condyle is accomplished by the action of the external pterygoid muscle, in a fracture of this type the condyle is located on the medial aspect of the ramus, where it may have become attached if the fracture is more than a week old. Because the muscular attachment remains intact, the condyle generally remains viable, with its blood supply passing through this muscle. Even if it is completely detached and has been removed at the time of the operation and

1. Walker, D. G. Fractures of the ramus, condyloid and coronoid processes of the mandible. Brit. D. J. 72:265 June 1; 72:293 June 15, 1942.

repositioned, it may still survive if it is replanted with proper fixation.

If left alone, the displaced condyle ceases to function and may become completely resorbed. The following case is an example of such resorption. A 13 year old boy suffered a fracture-dislocation of the condyle when he struck his chin against the dashboard during an auto accident (Fig. 4, above). Treatment consisted of immobilization of the mandible. The immediate result was satisfactory, but six months later the patient's jaw was found to be deflected to the injured side. A roentgenogram showed complete resorption of the condylar fragments (Fig. 4, below). The loss of the head of the condyloid process in a growing individual may prevent mandibular forward growth and cause facial asymmetry to develop later.

■ *Methods of Treatment*

There are essentially only two philosophies regarding the treatment of condylar fractures: either the fracture is permitted to heal without intervention, or it is reduced by open operation. The so-called conservative treatment by means of immobilization of the mandible does not allow positioning of the fragments. Condylar fractures cannot be reduced by manipulations, and they will heal in whatever position the fragments are found. The functional result therefore depends entirely on the fracture in case the diagnosis is favorable or on the reorganization of the temporomandibular joint. In young individuals there is considerable readjustment of the joint itself and of the occlusal relation, which is governed by functional changes in the joint.

Fig. 3—Condylar fractures. Left: Medial displacement. Center: Lateral displacement. Right: Fracture dislocation

Practitioners who have stated that they have never seen functional disturbances resulting from the healing of fractures in abnormal positions may not have followed up their cases over a long period of time. During the last five or ten years a considerable number of cases have been reported in which postoperative complications occurred after conservative treatment.[2-9] These complications included malocclusion, functional pain, limitation of motion, blocking of motion, pseudoarthrosis, arthritis and fibrous and bony ankylosis.

Whereas in conservative treatment the functional result is dependent entirely on the accidental position of the fragments, the result of the operative procedure depends in addition on the skill and experience of the operator both in the application of methods to restore normal anatomical relations and in the avoidance of operative complications.

It is logical therefore that the conservative treatment should be used for fractures with a favorable prognosis, while fractures with an unfavorable prognosis should be treated by open reduction.

The following are the indications for the operative procedure:

1. A unilateral fracture with considerable overriding of the fragments. The operation is necessary to avoid derangement of the joint on the opposite side.

2. A bilateral fracture with considerable overriding and resultant open bite, especially if there is no posterior occlusal support.

3. Gross malalignment of the condylar fragment so that it is situated at an angle to the ramus and projects over it.

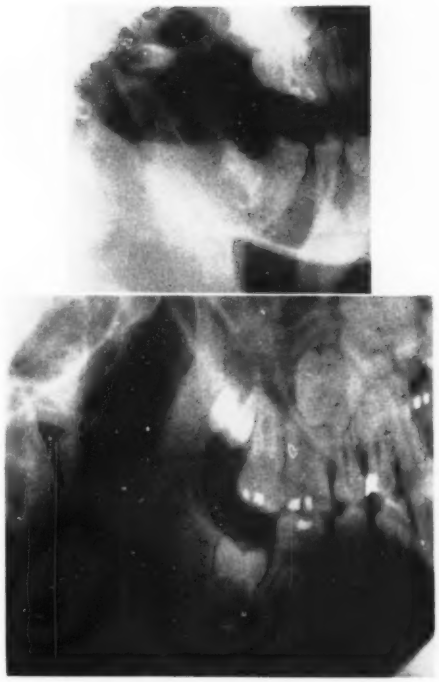


Fig. 4—Above: Fracture of head of condyloid process with displacement. Patient was 13 years of age. Below: Resorption of condylar fragment after six months

4. A position of the condyle that causes interference with the movement of the jaw or limits its opening.

2. Campbell, Willis C. Mobilization of ankylosed jaw. J.A.D.A. 19:1222 July 1932.

3. Risdon, F. The treatment of fractures of the jaws. Canad. M. A. J. 20:260 March 1929.

4. Federspiel, M. N. Incomplete and complete jaw ankylosis. J.A.D.A. 26:585 April 1939.

5. Gruber, L. W., and Lyford, John. The conservative treatment of simultaneous fractures through the necks of both mandibular condyles associated with multiple fractures of other parts of the mandible. Am. J. Orthodont. & Oral Surg. (Oral Surg. Sect.) 28:258 May 1942.

6. Thoma, K. H. Fractures and fracture dislocations of the mandibular condyle: a method for open reduction and internal wiring and one for skeletal fixation, with a report of thirty-two cases. J. Oral Surg. 3:3 Jan. 1945.

7. Thoma, K. H. Oral surgery, ed. 2. St. Louis, C. V. Mosby Co., 1952, p. 629.

8. Bradley, J. L. Ankylosis of the right temporomandibular joint. Oral Surg., Oral Med. & Oral Path. 5:241 March 1952.

9. Smith, A. E., and Robinson, Marsh. Mandibular function after condylectomy. J.A.D.A. 46:304 March 1953.

Fig. 5—Fracture through base of condyle, reduced and wired through submandibular approach

5. Fracture-dislocations.

6. Partly or completely healed fracture with arthralgia, abnormal function or malocclusion. Pain due to functional trauma or compensatory hyperfunctions may be experienced in the affected joint or in the opposite one. Abnormal function includes partial or complete ankylosis. Malocclusion includes open bite, closed posterior bite preventing the construction of dentures, and cross-bite.

Fig. 6—Condylar fracture treated by open reduction and transosseous wiring. Left: Before treatment. Right: After treatment

■ *Operative Procedures*

Two approaches have been developed. The older operation is performed through an incision in the preauricular region, the newer operation, introduced by Henny in 1951, through a submandibular incision.

The preauricular incision, either angulated vertically in the crease in front of the ear or carried through the tragus, without doubt gives a better cosmetic result than the submandibular one. It provides better access to the head of the condyloid process for procedures involving the capsule and the meniscus and for fixation of the head of the condyloid process in fracture-dislocation. The facial nerve is easily injured, however, not as much directly as indirectly through manipulation or retraction. The result is a temporary paresis of the eyelid and muscles of the forehead, which may last several weeks.

The submandibular incision avoids such neural complications, but it produces a more visible scar. It provides an excellent exposure of the condylar region and is especially recommended for subcondylar fractures (Fig. 2) and fractures low in the neck of the condyloid process (Fig. 5).

■ *Technic of Preauricular Operation*

Since the operation has been described in detail by Thoma,[6,7] only a few particulars are mentioned here. The condyle should be exposed from a posterior approach to avoid the facial nerve branches. The fragments should be fixed by means of stainless steel wire, no. 26 gauge. The holes in the fragments should be drilled obliquely from the external surface to the center of the fracture surface,

since holes so drilled provide better alignment than a hole drilled through both cortices. The fragment on the outside is drilled first, then the position of the fragments is changed to facilitate the drilling of the second one.

The administration of a skeletal muscle relaxant at this time greatly facilitates the procedure by relieving any muscular trismus that may be present. The drilling of the ramus fragment also is made easier if an assistant exerts pressure at the angle of the jaw to bring the fragment higher up into the incision. After the wire is placed—by direct insertion in the first fragment and pulled through the second fragment in a wire loop—the fracture is properly reduced and the position secured by twisting of the wire (Fig. 6).

The mandible must be immobilized for five to six weeks by any of the well-known methods. It is important that the immobilization be performed while the patient is under anesthesia, because otherwise the movements made during recovery or muscular trismus, which may develop postoperatively, will tend to displace the condyle. The external pterygoid muscle, especially, since it is attached to the condylar process, may cause twisting or otherwise displace a well reduced condylar fragment. If a condylar fracture is associated with a fracture in the body of the mandible, the hinge effect, which would allow the rami to spread apart and cause an angulation of the fragments, should be avoided by pushing the fragments medially after wiring.

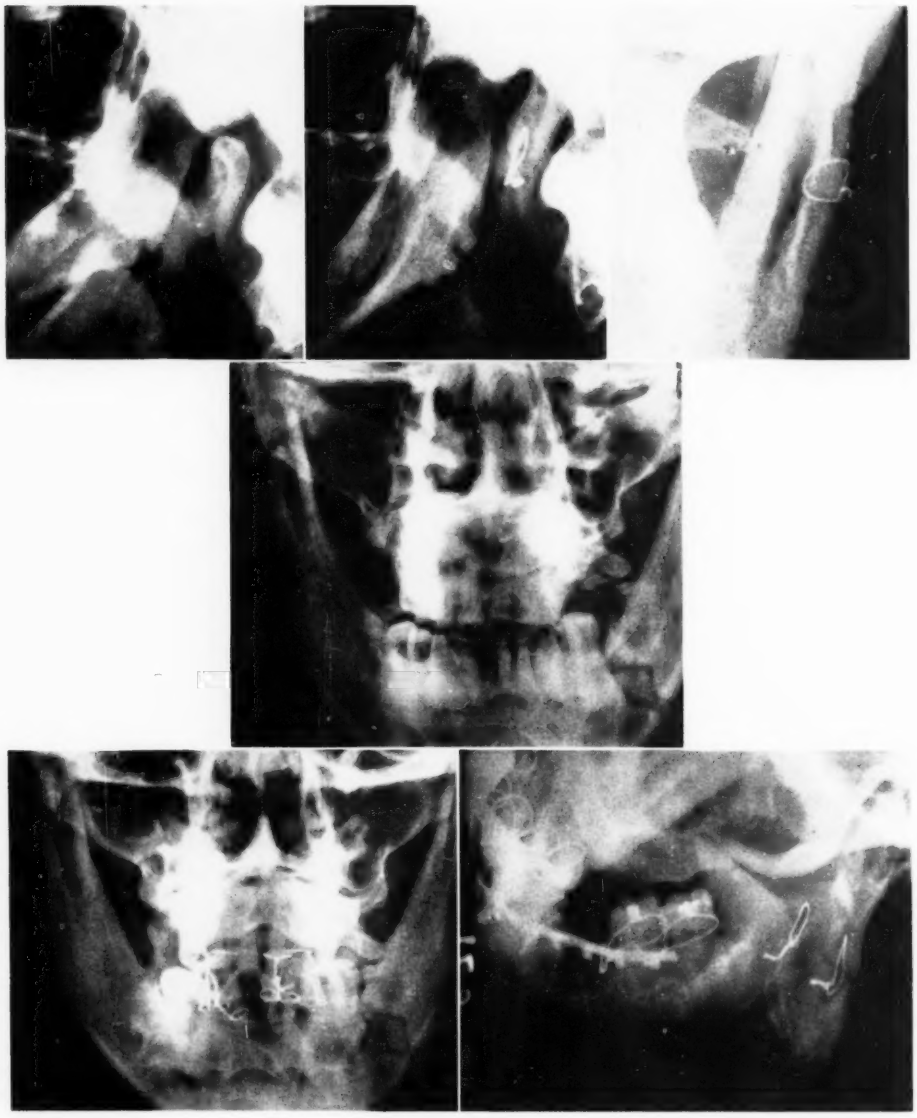
In fracture-dislocations the fixation of the dislocated condyle is of paramount importance. The tearing of the capsule leads to redislocation; and postoperative trismus of the external pterygoid muscle produces a medial and downward pull, which also tends to cause bending and redislocation. Wiring of the fracture is not always adequate to retain a reduced fracture-dislocation in position. Two methods can be used to prevent dislodgment. In the

Fig. 7—Skull showing method of fixation of reduced fracture-dislocation

first method, two short pins are employed in the same way in which they are used for skeletal fixation. In the second method (Fig. 7), a fine hole is drilled through the condyle and the zygomatic arch with the dental engine; and a chromic catgut suture is inserted, which will prevent redislocation and will dissolve by the time function is allowed or the fracture has healed sufficiently.

The fracture itself is wired in the usual manner, and the mandible is properly immobilized. If pins are used for

Fig. 8—Above, left and center: Lateral view of condylar fracture before and after reduction. Above right: Subcondylar fracture reduced and wired through submandibular approach. Center and below left: Antero-posterior views of fractures, same as in above, left and center, before and after reduction. Below right: Fracture through base of condyle, fixed by means of two wires to prevent twisting of condylar fragment



fixation of the dislocation, these may be removed after five to ten days. Roentgenograms should be taken before and after the removal of the pins used for fixation.

■ *Technic of Submandibular Operation*

The reduction of subcondylar fractures (Fig. 2) and fractures at the base of the condyle (Fig. 5 and 8, above, left and center) has always presented a considerable problem, since such fractures cannot be approached easily through a preauricular incision. The method, reported by Thoma[10] in 1948, of reducing a subcondylar fracture through a submandibular approach greatly facilitates the operation.

In 1951, Henny[11] recommended the submandibular incision for all condylar fractures, since it gives adequate access inferiorly, a factor which is of great importance in low fractures. This method provides satisfactory exposure of the medial and anterior portions of the condylar fragment as well as of the entire ramus and eliminates injury to the ramification of the facial nerve.

In the technic, which was described by Henny in 1951 and Thoma in 1952, the entire component of the skin, parotid gland and masseter muscle is elevated. Injecting a muscle relaxant at the proper time facilitates retraction and the exposure of the condyle and allows easy manipulation of the condylar fragment. In addition to making it possible to wire subcondylar (Fig. 8, above right) and condylar fractures through the base of the condyle (Fig. 5) with ease, this method makes it easy to manipulate the condyle into the proper position (Fig. 8, above, left and center; center; and below left). If it is indicated in cases where a tendency to twisting is encountered because of the line of fracture, two wires can be applied without difficulty to prevent displacement (Fig. 8, below right). When the wound is closed, the masseter muscle must be replaced carefully and sutured in position by means of chromic catgut. Again, the jaw must be kept correctly immobilized until healing has taken place.

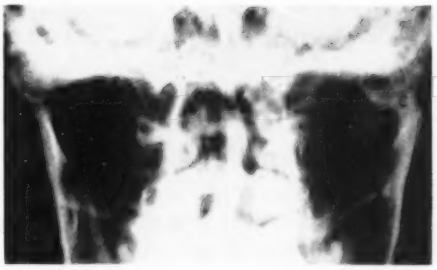


Fig. 9—Completely detached condyle which had been replanted and held in position by skeletal fixation

■ *Condylectomy and Replantation*

A condylectomy should not be performed in a case of a recent fracture even though the roentgenogram shows extreme displacement. It has been demonstrated that completely detached fragments of bone can be replanted and, if properly immobilized, have a very good chance of remaining viable and useful (Fig. 9). In many old malunited fractures which cause pain and debility, a condylectomy must

10. Thoma, K. H. New methods for immobilization of the mandible. Oral Surg., Oral Med. & Oral Path. 1:98 Jan. 1948.

11. Henny, F. A. A technic for open reduction of fractures of the mandibular condyle. J. Oral Surg. 9:233 July 1951.

be resorted to, especially if there is ankylosis of the joint.

Smith and Robinson[9] resorted to arthroplasty in one case in 1953. Their procedure consisted of bilateral reconstruction of the mandibular condyles with iliac bone grafts and creation of a new joint by means of inserts of nonelectrolytic metal. While many patients without mandibular condyles do have adequate function in mastication, arthroplasty is indicated in those cases in which re-education of the patient's neuromuscular mechanism cannot be accomplished in order to place the major forces of mastication within the denture region.

In the past, there has been a tendency to by-pass the primary rules of fracture treatment in dealing with fractures of the condyle. The fact that the hazards in this region are greater is no justification for ignoring established orthopedic principles. The goal continues to be restoration of anatomical continuity and free function. Every fracture should be examined postoperatively; and the final result should be evaluated in terms of anatomy, function, comfort and esthetics.

Treatment of fractures of the mandible with intraoral appliances

■ *Henry B. Clark, Jr., M.D., D.D.S., Minneapolis*

Since antiquity the teeth have been used for the attachment of various appliances for the reduction and fixation of mandibular fractures. The unique advantage derived from using the teeth for attachment of appliances is accompanied by a liability —the necessity of securing such precise reduction of fractures that these teeth will be in good occlusion at the end of treatment.

The importance of these two prime considerations in the treatment of mandibular fractures varies with the number of teeth present. When only a few broken down units of the dentition remain, the ease of fixation will be reduced, but restoration of fragments to their preinjury relationship need not be so exact. When all mandibular teeth are absent, there is no occlusion to restore; hence prompt union of bones in reasonably good position is a proper goal.

If the principles underlying fixation

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of the jaws are well understood, it should not be difficult to secure good results. The simplest method that will insure prompt union and restoration of good occlusion should be selected. It is better to master a few methods of treatment and use them often rather than to change constantly from one to another. Intricate and elaborate devices should be avoided whenever possible because of the cost involved and the time required for construction.

It has been stated that 90 per cent of fractures of the mandible can be managed by wiring the teeth in occlusion,[1, 2] and that when sufficient teeth are present, wiring them in occlusion will constitute the best form of treatment. It is certain that in the matter of simplicity, low cost, freedom from complications, and insurance of good final occlusion, wiring methods have much to commend them. For the small remaining group of cases that present special situations, other treatment plans must be devised.

■ *Intraoral Technics*

Intraoral technics that have been used and reported for care of fractures of the mandible can be grouped into four general categories, based on the effects they achieve:

1. Indirect dental fixation.
2. Direct dental fixation.
3. Indirect skeletal fixation.
4. Direct skeletal fixation.

Each of these may be considered for use in three main types of situations:

1. Fractures of the mandible with full dentition present.
2. Fractures of the mandible with partial dentition present.
3. Fractures of the edentulous mandible.

Indirect or direct dental fixation is indicated when the full dentition is present, sometimes indicated when partial dentition is present, but not indicated when the mandible is edentulous.

Indirect or direct skeletal fixation is contraindicated when the full dentition is present but sometimes is indicated when partial dentition is present. These methods are indicated when the mandible is edentulous.

Combinations of various methods are frequently used. Further complexity develops when combinations of these methods and extraoral devices are used. The present discussion will indicate situations that require mixed or combined types of appliances.

■ *Methods of Treatment*

For the most part, details of technic will be omitted from this review as they are to be found in any standard text on oral surgery.

1. Indirect dental fixation is immobilization of the fractured bones through securing upper and lower teeth together in occlusion by means of wires, elastics, or other appliances. The interlocking effect of the cusps, grooves and sulci of upper against lower teeth insures precise reduction of the fracture and good ultimate functional occlusion (Fig. 1, left). Maintenance of closure of the jaws for a prolonged period is implicit in this

1. Ivy, R. H., and Curtis, L. Fractures of the jaws, ed. 3. Philadelphia, Lea & Febiger, 1945, p. 50, 57.
2. Padgett, E. C. Surgical diseases of the mouth and jaws. Philadelphia, W. B. Saunders Co., 1938, p. 132, 136, 139.

Fig. 1—Left: Indirect dental fixation. Immobilization is achieved by the interlocking effect of cusps, grooves, and sulci of upper against lower teeth. Right: Ivy twisted loop or eyelet method of wiring to secure indirect dental fixation. Three to five such "units" are used

method. The more commonly used methods of applying this principle are: (a) wiring the teeth and applying intermaxillary fixation by use of Gilmer's method, Ivy's twisted loop method, Stout's (Army) continuous loop method, Kazanjian's button method, Risdon's arch method or the single tooth tie method; (b) use of arch bars plus intermaxillary fixation, such as the arch bar with hooks, the Jelenko splint or the Winter splint.

Annealed brass wire in 24, 25, or 26 gauge may be used in these technics, but the greater strength of annealed stainless steel wire makes the use of the latter more satisfactory. A minimum of equipment is required: two hemostats, a needle holder, a wire cutter, a retractor, and an explorer usually will suffice.

GILMER METHOD—The method of Gilmer, introduced in 1887,[3] is the simplest of all intermaxillary wiring methods, but it produces undue strain on a few teeth and necessitates the removal of all wiring if the mouth has to be opened during treatment.

TWISTED LOOP METHOD—The twisted loop or eyelet method popularized by Ivy[1] (Fig. 1, right) permits the mouth to be opened during treatment without disturbing the basic interdental wiring; it distributes stresses over more teeth, but limits the number of possible points to which intermaxillary tie wires may be affixed. Nonetheless, this method has enjoyed wide popularity because of the relative ease of application and the security of the fixation achieved. In cases where fragments are badly displaced, the intermaxillary tie wires may be tightened gradually over a period of several days, which brings the teeth into improved occlusion and reduces the displacement of fragments. Elastic bands may be applied to the hooks formed by the twisted wire ends, but if this form of traction is desired another method usually will serve to better advantage.

CONTINUOUS LOOP METHOD—The Army continuous loop method (Fig. 2, left) introduced by Stout was devised to permit early intermaxillary elastic traction and fixation for battle casualties in forward areas. The elastics may be cut with

3. Gilmer, T. L. A case of fracture of the lower jaw with remarks on the treatment. Arch. Den. 4:388 Sept. 1887.

scissors in the event of nausea incident to motion sickness during ship, plane, or ambulance evacuation. When the patient reaches a base hospital, another type of wiring may be preferred which will permit placement of intermaxillary tie wires. The loops of the Army method do not hold up well when tie wires are used in place of elastics unless extremely heavy basic wiring has been used.

BUTTON METHOD—Twisted wire buttons or "rosebuds" used by Kazanjian[4] have the advantage of simplicity of application. Against this advantage, however, must be weighed the factors of bulk, strain on individual teeth, and the tendency of the elastics to become inextricably wedged into the recesses of the wire mass.

RISDON METHOD—Of all the methods that we have used at the University of Minnesota that of Risdon[5] has been most universally satisfactory. The flexible cable arch bar provides many sites of attachment for wires or elastics (Fig. 2, right). No unintended buccolingual orthodontic effect is introduced as the cable is dead soft. Many teeth share the load that results from traction applied at any point on the arch to bring fragments into position. The technic permits forceful apposition of fragments (direct dental fixation) as well as indirect dental fixation.

SINGLE TOOTH TIE—Occasionally it is necessary to attach an elastic band or tie wire to a single tooth that stands alone. Many devices have been reported for this purpose that range in complexity from specially made orthodontic bands to single wires passed around the tooth. We have found the double wire (Fig. 3) simple and serviceable. The overhand knot serves as an eyelet to receive a tie wire while the curved twisted end may be used as a hook to secure an elastic band if fairly heavy wire has been employed.

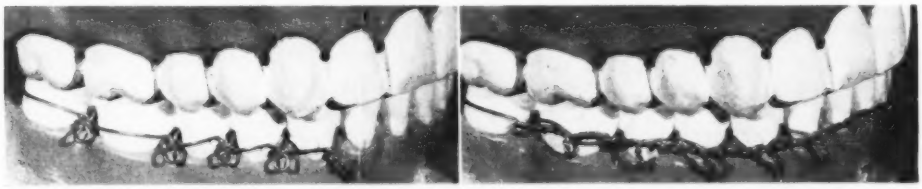
HOOKED ARCH BARS—Hooked arch bars of the Jelenko, Winter, or individually fashioned type are strongly favored by some writers, particularly for gradual reduction of displacements in fractures received for treatment several weeks after injury. Erich and Austin[6] describe a style of bar which may be

4. Kazanjian, V. H., and Strock, M. S. Early treatment of fractures of the mandible. J.A.D.A. 29:76 Jan. 1942.

5. Risdon, F. Treatment of fractures of the jaws. Canadian M.A.J. 20:260 March 1929.

6. Erich, J. B., and Austin, L. T. Traumatic injuries of facial bones. Philadelphia, W. B. Saunders Co., 1944, p. 527, 528.

Fig. 2—Left: Army continuous loop wiring method. Wiring such as that shown is applied to all four quadrants, and rubber bands are added to give indirect dental fixation. Right: Risdon arch method. Forceful apposition of fragments may be secured during wiring procedure, and intermaxillary traction may be applied at any desired point with tie wires or elastics



punched out of Monel metal with hooks attached which are later bent over. They feel this material is sufficiently pliable to permit adaptation to the teeth with finger pressure. This feature would obviate one of the inherent objections to the rigid arch bar principle—the necessity of making a model to permit easy and exact contouring to labial and buccal surfaces of the teeth

Fig. 3—Single tooth tie, useful for securing traction or fixation to an isolated tooth

prior to wiring in place. Erich and Austin state that any arch bar of this type should be cut where it crosses the fracture line so that distraction of fragments with consequent nonunion will not occur. Ivy and Curtis[1] feel that if a divided arch bar is used for traction on displaced fragments it should be replaced by a continuous arch after reduction is complete. It must be recognized that rigid appliances, both intraoral and extraoral, may introduce the serious problem of distraction of bone ends. The high degree of success of indirect dental fixation no doubt is due in part to the subtle provision for falling together of bone ends. The rigid appliance is entirely suitable for bone grafting procedures or when good fragment contact is known to exist. Ivy and Curtis describe a useful variation on the divided arch bar principle which they credit to Schellhorn. Expansion of a collapsed arch in the symphysis region is achieved by lateral elastic traction between two sections of bar lashed to the teeth. The rubber bands are applied to U-shaped projections from the arch bar segments. When sufficient separation has been achieved the appliance may be replaced by a single bar.

2. Direct dental fixation is the immobilization of fragments by means of a splint, bar or wire that extends between two or more teeth on opposite sides of the point of mobility (Fig. 4). Ideally, this method allows the mouth to be opened at will during the period of treatment. While this consideration is immediately appealing to the patient, the opening of the mouth introduces certain hazards. If rigid immobilization is not secured, if fragments are distracted, or if occlusion is not achieved after the fracture is healed, the enjoyment of being able to open the jaws during treatment becomes a costly privilege. The most frequently used appliances for direct dental fixation are wiring, the Risdon flexible arch, rigid arch bars, splints (cast silver cap type, sectional acrylic resin or silver type).

WIRING AND ARCH BARS—The simplest of direct dental fixation technics would be surrounding the two teeth adjacent to the fracture line with a single wire and tightening it securely. Unfor-

tunately this provides little stability and places unwarranted lateral stresses on the supporting structures of these teeth. An arch bar fashioned of twisted annealed wire (Risdon) or of rigid tempered wire, lashed to several teeth on either side of the fracture line, is an improvement in the matter of tooth strain but is unlikely to offer adequate immobilization for a complete fracture of the mandible unless combined with indirect dental fixation. Fractures of alveolar process only are well cared for by arch bar fixation alone.

SPLINTS—Splints constructed in the laboratory from models have been used by many workers and are of several designs and types. The maximum of rigidity and security of attachment for long-term fixation (in bone grafting or for pathological fracture) is achieved by the use of cast silver cap splints attached to the teeth with red copper cement. The number of variations is limited only by the degree of ingenuity of the dentist (Fig. 5). Splints of this type may be cast as a single piece or in sections, to be assembled in the mouth and joined by screws, pins or other types of locking devices. While cap splints do not permit closure of the teeth in centric occlusion during the period of treatment, Fry[7] and others who have had wide experience with them feel this defect is not serious, for normal occlusion can be established after the splint is removed. If the fracture lines lie solely within the span of this appliance, intermaxillary fixation may be omitted. Construction of a cast silver cap splint is relatively simple in principle. Impressions are taken of upper and lower arches with alginate or hydrocolloid. Models are made and articulated.

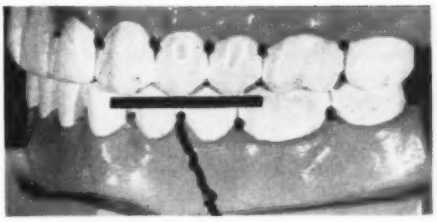


Fig. 4—Direct dental fixation. Splinting effect is gained from bridging the teeth on either side of fracture with rigid or semirigid appliance. Care must be taken not to hold bone fragments in slight separation by this method

One or two layers of pink denture wax are warmed and adapted to the section of the lower arch which is to receive the appliance. By frequent removal during shaping of the wax pattern, undercuts are eliminated. Indentations are provided for teeth in the opposing arch. The splint is cast in coin silver.

The U. S. Army Dental Corps[8] has favored sectional splints of the open occlusal type made of acrylic resin or cast silver. Appliances of this type made of

7. Fry, W. K., and others. The dental treatment of maxillofacial injuries. Philadelphia, J. B. Lippincott Co., 1945, p. 155.

8. Ivy, R. H., and others. Manual of standard practice of plastic and maxillofacial surgery. Philadelphia, W. B. Saunders Co., 1942, p. 272, 322.

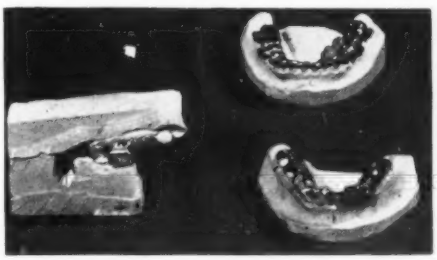


Fig. 5—Cast silver cap splints, used for direct dental fixation. (Courtesy S. Koontz, Veterans Hospital, Minneapolis)

acrylic resin, however, have numerous defects which make them inadequate for difficult cases and unnecessary in simpler ones which could be cared for nicely by intermaxillary wiring. If the teeth are not sufficiently bell-shaped, retention is difficult, for acrylic resin does not have the rigidity of metal. Furthermore, they are unclean and encourage inflammation of the gingival tissues on which they rest. When made of silver the sectional splint has better rigidity but construction is more difficult than is construction of the cap type. Cementation to the teeth would help in the matter of cleanliness but is not recommended by the proponents of sectional splints.

In summary, if a splint is to be used there should be absolute therapeutic indications for it to justify the additional laboratory and chair time, and it should be superior in the matters of cleanliness, security of attachment and rigidity.

3. Indirect skeletal fixation achieves stability of the fractured bones by molding the displaced or mobile fragments to a denture or saddle splint by means of wires, bandaging or skeletal traction. Methods for treatment of completely or partially edentulous patients include: Dentures or Gunning splint with head bandage, dentures or Gunning splint with skeletal fixation to head cap, circumferential wiring, and Berry intraoral pin fixation.

The simplest method is insertion of the patient's own complete upper and lower dentures with application of an elastic bandage exerting upward traction on the mandible. Waldron[9] has demonstrated that much greater comfort will be provided if a head cap having lateral projections of sheet metal is constructed for this purpose. The elastic bandage is fastened to these outriggers and in this way pressure is removed from the malar and temporal regions. If the dentures are not available, a splint may be fashioned from models of the arches after the method of Gunning.[10] Although these methods may be criticized on many counts, their simplicity and conservatism recommend them for uncomplicated cases.

A combined intraoral and extraoral method for treating certain fractures of the edentulous mandible consists of passing a Steinmann pin transversely through the mental protuberance and attaching it to a plaster head cap with suitable clamps and vertical sections of welding rod material. This seemingly radical measure is actually well tolerated by the patient and eliminates the discomfort and lack of security inherent in bandages. It may be used as a supplement to direct bone wiring or as a substitute for the bandage in the technic described earlier.

Circumferential wiring with assemblage of multiple mandibular fragments against a lower denture or saddle splint has been ardently advocated by many writers[1, 2, 6, 8] as a good method for treating fractures in partially or completely edentulous patients. This method was abandoned long ago at the University of Minnesota Dental School after it was seen that mucosal pressure ulcers and excruciating pain were produced when the wires were tightened sufficiently to produce immobility of the fragments. It is our feeling

9. Waldron, C. W. Personal communication.

10. Gunning, T. B. Treatment of fractures of the lower jaw by interdental splints. New York M.J. 3:433 Sept.; 4:11 Oct. 1866.

that an open reduction with wiring or plating, combined with administration of antibiotics, is now the treatment of choice for this class of fractures, if the simpler methods mentioned earlier are not adequate.

Berry[11] has devised a method of intraoral screw and bar fixation that provides indirect skeletal fixation in much the same way that the Roger Anderson appliance does externally. The connecting bar joining three vertical screws is adapted with pliers to give the desired position of bone fragments.

4. Direct skeletal fixation (Fig. 6) is the uniting of fractured bones by mechanical means through an open operation. These procedures usually are performed from the extraoral approach so that an aseptic field can be maintained. The technics that provide this effect are plating and direct bone wiring.

Open reduction of fractured mandibles has been avoided in the past because of the dread of osteomyelitis. With prophylactic antibiotic therapy these procedures are now performed as a matter of course, even in the presence of salivary contamination, with prompt healing the usual result. The application of a Lane or Ferguson plate from an intraoral approach is virtually impossible except in the anterior region, and even here the superior access provided by an external wound makes the latter course preferable. Intraoral direct bone wiring is technically feasible and has been reported by Kazanjian,[12] but this too is generally accomplished through an outside incision. The latter permits good exposure of the lower border of the mandible so that fragments can be precisely reduced and fixed. Plating provides excellent stability but should be used with caution in cases where teeth are present, for some slight warping from the preinjury alignment is almost certain to occur with consequent malocclusion. Direct bone wiring with a single loop or two loops in criss-cross fashion permits fragments to assume proper position and carries the advantage mentioned earlier in connection with wiring of teeth—that the bone ends are not held apart by any rigid device. Direct bone wiring should be supplemented with intermaxillary fixation whenever possible.

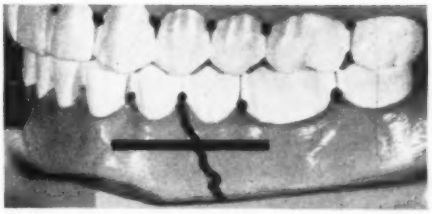


Fig. 6—Direct skeletal fixation. Immobilization is produced by plating or wiring the fragments

One final method of intraoral fixation, difficult to classify under the headings used in this discussion, will be mentioned briefly to illustrate the commendable tendency to abandon complex gadgets when superior treatment methods become available. For control of an upriding posterior edentulous fragment, Kazanjian[12] in 1933 recommended a splint on the lower posterior teeth with a projection prong extending downward and backward to engage the anterior aspect of

11. Berry, H. C. A new departure from orthodox methods of setting fractured edentulous mandibles. J.A.D.A. 28:388 March 1941.

12. Kazanjian, V. H. Treatment of automobile injuries of the face and jaws. J.A.D.A. 20:757 May 1933.

the ramus. Padgett[2] described a similar method which consisted of a splint applied to the upper molars with an extension bar containing a jack screw for downward and backward reduction of the displaced fragment. He conceded that the appliance was difficult to make and was uncomfortable for the patient. In the only instance where we have seen this method tried, much pain and little control resulted. In 1942, after the advent of antibiotics, Kazanjian[4] stated that he had modified his former view and had come to favor open reduction for fractures where there was considerable displacement that involved an edentulous fragment.

This instance typifies the proper evolution of better methods of treatment that are likely to result from any pertinent new discovery in the field of science. The principles doubtless will remain, but the application of them will change in many ways with the passing years.

Summary

1. Fractures of the mandible are best treated by the simplest appliance that will fulfill the criteria of good reduction, intimate contact of bone ends and absolute immobility.

2. Greater success will be achieved by the repeated use of relatively few technics, so that the limitations and possibilities will become well known to the operator.

3. Indirect dental fixation with good appositioning of fragments is achieved by the use of Risdon arches and intermaxillary tie wires.

4. When long-term direct dental fixation is required, cast silver cap splints provide the maximum of rigidity, security and cleanliness. In selected cases the mouth may be left open during treatment.

5. Fractures of the edentulous mandible should be treated by conservative means when possible, as good union even with slight displacement constitutes a satisfactory result. If surgical intervention is indicated, direct skeletal fixation together with antibiotic therapy will give gratifying results.

Human Resources

There were about 200,000 fewer deaths in our country in 1950 than would have occurred if the death rate of 1945 had continued unchanged. This is an outstanding achievement in life conservation for so brief a period and is attributable largely to the rapid advances in medical science, the steady rise in the general standard of living, and improved safety measures. If the mortality of 1945 by age, sex, and color had prevailed in 1950, the year would have seen almost 1,657,000 deaths, in place of the 1,452,454 actually recorded.—*Statistical Bulletin 34:4 March 1953.*

Management of fractures in children

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This incidence of traumatic injuries of the orofacial region has increased because of the highly mechanized way of life in the twentieth century. Excellent progress has been made in recent years in the treatment of facial injuries, but for some reason the treatment of the adult patient has been stressed primarily. Although the general approach to maxillary and mandibular fractures is the same for the adult as for the child patient, nevertheless, there are specific factors which must be taken into consideration in the planning of treatment for children.

The purpose of this paper is to point out some basic principles in the management of traumatic injuries in children.

Sound knowledge of normal anatomy and physiology as it applies to the child patient who is to undergo surgery is necessary in order to understand the rationale of treatment. The growth of the face is extremely rapid during the first year of life; the width of the palate is five-sixths complete by the fourth year.[1] The mandible grows by surface deposition at the posterior and superior border of the ramus and resorption of the anterior border. By the sixth year, about 60 per cent of the size of the adult face is reached.

The presence of the buds of the developing teeth makes the mandible fragile and predisposes it to fractures. The maxilla is better protected by the buttressing action of the facial bones which articulate with the maxilla. The eruption of the deciduous and permanent teeth occurs during the first 12 years of life. Severe injuries sustained during the first six years of life may cause interference with normal growth and development, and facial deformities may result if the injuries are not treated properly.

Since callus formation is rapid in children, delayed or improper treatment may result in aberration of growth, malformation loss of function and disfigurement.

The deciduous and mixed dentitions present great problems of retention in conventional immobilization such as ligature wiring, arch bars or intermaxillary elastic traction. The deciduous teeth have short, bulbous crowns with little or no undercuts on the buccal and lingual surfaces, and consequently are poor abutments for any type of ligature wiring.

The deciduous dentition changes rapidly after the eruption of the permanent teeth begins. When the child is six years of age the first molars usually are erupting, but they cannot be ligated suc-

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1. Cohen, M. I. Orthodontic technique for reduction and immobilization of bilateral compound fracture of the mandible in a young child. Oral Surg., Oral Med. & Oral Path. 5:10 Jan. 1952.

cessfully at the onset of their eruption since their crowns are only partially exposed and their roots are short and incompletely calcified.

The mixed dentition is unfavorable for the same reason, and since the determination of normal occlusion is difficult at that time, reduction and fixation is especially complicated. In the mixed dentition the simple masticatory cycle of the deciduous dentition undergoes changes, and the complex pattern of the adult masticatory function develops. Caries susceptibility is high and the periodontal support of the permanent teeth is not yet fully developed.

■ *Causes of Fractures*

Maxillary and mandibular fractures result from a multitude of causes. They may be sustained in the home through falls or accidents. They also may occur during play or brawls, or can be caused by specific accidents such as automobile crashes, war injuries, assault and various other trauma. In addition, pathologic fractures may occur during oral surgical procedures or after osteomyelitis or removal of a tumor.

■ *Psychology of the Child Patient*

The child patient presents a different psychological problem from the adult. Often the child is brought to the dentist after trauma has been sustained and the child has had no previous dental experience. In such instances it is difficult to obtain sufficient cooperation from the child and it is not practical to try to give the child dental training when emergency treatment is indicated. Sedation often is necessary before an examination can be performed successfully. General anesthesia is preferable in cases where closure of facial wounds or reduction of fractures must be carried out.

Hospitalization is recommended in the majority of cases since, from a psychological point of view, it presents many advantages. The patients are in close contact with many other children who are undergoing treatment for various conditions, friends are acquired rapidly, play, and distraction from the patient's personal problem by the example of the other children, usually develops sufficient courage and confidence in a child and he is anxious to "take it" as the others do. The routine of a pediatric ward, with the warm, sympathetic, courteous and firm manner of the medical, dental and nursing staffs, goes a long way toward the establishment of the necessary rapport that makes a good dental patient out of the child.

■ *Examination*

To obtain the best functional and cosmetic result, it is essential to establish a correct diagnosis and plan the treatment carefully. As a rule an elaborate examination cannot be performed when the patient is seen for the first time in the office or in the hospital. Emergency treatment must be rendered; nevertheless, some essential data must be obtained. A short medical and dental history is taken to find out if there have been any neurologic or internal injuries. Information as to when, how and where the accident occurred and which part of the body sustained the greatest traumatic impact gives clues as to the involvement and extent

of the injuries. Subjective symptoms that appear immediately after the accident often are informative. A medical examination is always indicated so that any medical emergency such as skull fracture, cerebral concussion, internal injuries and hemorrhage, shock, and possible fractures of other bones may be ruled out. The specific extraoral and intraoral examination is aimed at determining the extent, location, type and severity of the facial injuries. Deviation from normal occlusion, the compounding or comminution of the fractures and the loss of soft and hard tissues must be noted. The teeth and supporting structures are examined carefully.

A complete roentgenographic examination is indicated at the earliest convenience, after any emergency situation that endangers the life of the patient is under control. Blood count and urinalysis are routinely performed if there has been any injury that involves the facial bones. If the injuries are relatively minor, a more complete oral examination is performed after the child has been given adequate sedation, preferably with one of the rapid-acting barbiturates.

After the extent, type and location of the injuries have been determined accurately, a step-by-step treatment plan is prepared and carried out with attention to minute details.

Injuries may involve only the teeth. Fractures of the permanent teeth are extremely common in children and may involve either the crown or root. They frequently are observed concurrently with a maxillary or mandibular fracture (Fig. 1, left). Luxation of permanent teeth occurs infrequently and may be associated with severe facial injuries. Replantation can be attempted, but root resorption and secondary infection occur in many cases.

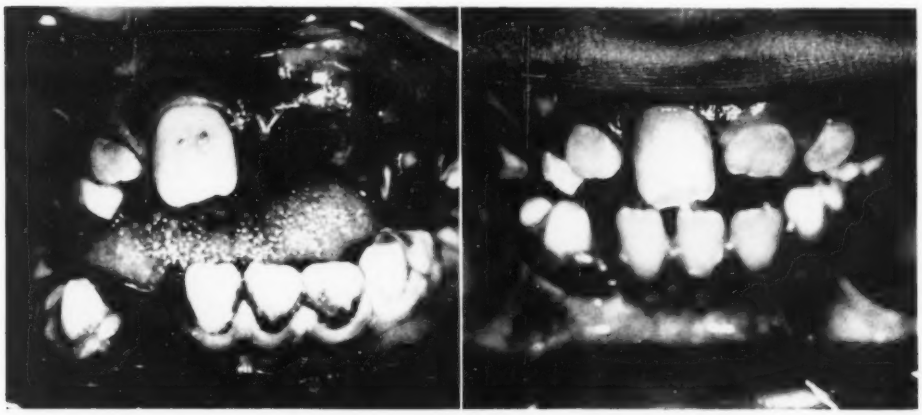

Fig. 1—Left: A seven and a half year old boy had sustained multiple facial injuries. Upper left permanent central and lateral incisors were impacted into alveolar bone and left deciduous cuspid was fractured. Mandible was fractured in symphysis region along axis of right lateral permanent incisor which was traumatically removed. There was downward and lateral displacement of right fragment. Right: Same patient, two months postoperatively. Upper left central and lateral incisors starting to re-erupt. Left deciduous cuspid has been extracted. Fracture has been reduced and immobilized with orthodontic appliances and has healed normally

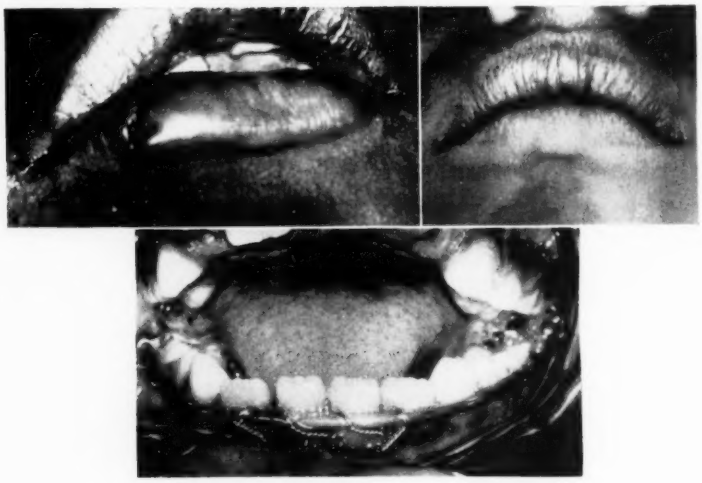

Fig. 2—Above left: Laceration of lower lip of six and a half year old Puerto Rican boy with fracture of mandible in right symphysis region between lower right lateral and central incisors. Above right: Same laceration two years later. Lip has healed completely and scar is almost invisible. Below: Same patient as shown above. Compound fracture of mandible in symphysis region between right central and lateral incisors; orthodontic appliance in place. Molar bands and arch bar were inserted with patient under general anesthesia. Fracture was reduced by manipulation before insertion of labial arch

Impaction of permanent teeth into the soft tissue or bone is seen frequently (Fig. 1, left). Re-eruption of the impacted teeth usually occurs if secondary infection can be prevented (Fig. 1, right). In cases where the teeth have been impacted, reduction of the fracture and immobilization with splints also can be attempted. Loss of vitality is the usual sequela of this procedure, however, and root canal therapy is indicated after the tooth is firmly implanted in the arch. The majority of such injuries are accompanied by soft tissue laceration as well as bone fractures.

■ *Soft Tissue Lacerations*

Bruises and contusions are the rule when a fracture is present. They are best treated with cold applications to reduce the edema and swelling. Large hematomas may require aspiration. The suturing of lacerations may be managed either by primary or secondary closure; the choice of method depends on the circumstances.

When the wound is not obviously infected, is seen soon after the injury, and is accompanied by little or no soft tissue loss, primary closure is indicated (Fig. 2, above left). The wound is débrided conservatively and is closed in layers.

Good cosmetic results depend on a carefully approximated suture line free of tension, with slightly eversed margins and good support by underlying tissues. Fine silk or synthetic suture material with

atraumatic needles are used for final skin closure. Repair of the lip is particularly difficult, and precise approximation is imperative, especially at the mucocutaneous border (Fig. 2, above right). If fractures are present, they should be reduced before lacerations are sutured, since manipulation is difficult at a later date without interfering with the healing process of the wound. As the facial bones support the soft tissue, it is desirable to restore the normal contour and position of the fractured bone before proceeding with the final repair of the soft tissues. If no hemorrhage is present, intraoral lacerations are sutured after the reduction of the fractures.

Secondary repair of soft tissue lacerations usually is reserved for those cases where the wound is obviously infected or where the patient's condition at the time of reduction was too poor to allow any operative treatment.

■ *Fractures*

The management of fractures requires (1) immediate emergency treatment and (2) reduction and fixation of fractures.

IMMEDIATE EMERGENCY TREATMENT —Injuries of the face usually are not fatal, even in severe cases. It is always necessary, however, to rule out other complications that might endanger the patient's life. Consequently, the first consideration should be the general condition of the patient, not the immediate reduction of the fracture. The recognition and treatment of hemorrhage, shock, impaired airway or skull and internal injuries are always of primary concern.

The airway of a seriously injured child should be checked immediately. A severe blow to the face may result in a fracture of the maxilla with subsequent depression of the entire middle of the face which may obstruct the airway either by the mechanical displacement or by hemorrhage. If such a condition exists, it is not difficult to raise the maxilla by inserting tongue blades or some other suitable instrument into the mouth and, by the use of upward and forward pressure, relieve the depression.

Bilateral fracture of the anterior portion of the mandible, with severe posterior displacement, may allow the tongue to drop posteriorly and occlude the airway. In such a case the tongue must be pulled forward at once and be held there, either by a suture or a safety pin through the tip of the tongue. If a child is unconscious, blood may accumulate in the pharynx and cause obstruction. If this should happen, aspiration is indicated to clear the airway, and the head should be turned to one side so that the blood can flow out of the mouth.

The next important consideration is the control of hemorrhage. Hemorrhage in facial wounds usually can be checked without too much difficulty. Pressure will stop most of the bleeding, but active bleeding points usually are ligated with catgut or chromic ties.

Neurologic symptoms must be given careful consideration. Low pulse rate, severe headache, bleeding from the ears, nose or oropharynx, projectile vomiting, or drowsiness should lead one to suspect the possibility of a skull fracture or serious neurologic involvement.

If a skull injury exists it may be

necessary to defer treatment of the facial fractures for several days until the patient has recovered sufficiently to withstand an operative procedure.

The last phase of emergency treatment is conservative débridement and closure of the facial wounds and temporary immobilization of the bone fragments, if possible.

Necrosis of soft tissue is rare since the blood supply of the facial structures is good, and healing usually occurs even in severely injured tissue.

REDUCTION AND FIXATION OF FRACTURES—According to Kazanjian[2] about 10 per cent of all mandibular fractures occur in children between the ages of 4 and 11. Maxillary fractures are rare. Mandibular fractures may be treated by the following methods:

1. Wire ligatures with intermaxillary traction or any modification thereof.
2. Splints.
3. Orthodontic reduction and fixation appliances.
4. Direct interosseous wiring.
5. Extraoral elastic traction.
6. Complex treatment methods (combinations of open reduction and fixation; extraoral pin fixation or wire traction with head gear; circumferential wiring combined with intraoral splint).

FRACTURES OF THE MAXILLA—Fractures of the maxilla are rare in children since the mandible protects the middle of the face and absorbs most of the trauma, and the cancellous bone of the maxilla possesses a certain elasticity.

Alveolar fractures are not uncommon and rarely are serious. It usually is sufficient to remove the necrotic bone splinters, débride the soft tissue wound, reduce the fracture and ligate the teeth to a labial arch bar. If only the first permanent molars and deciduous teeth are present for anchorage, an orthodontic appliance can be constructed similar to the one used for mandibular fractures.

In major accidents, complicated facial injuries may occur. Fractures of the maxilla, nasal bones, zygoma and orbit may all be present at the same time. The management of such cases varies; it depends on the complexity, extent and severity of the injuries, and no hard and fast rules can be drawn. Fundamental principles are observed in such cases which aim at the restoration of a functional occlusion, of facial contour and harmony, support of orbital contents, and correction of the displaced bony fragments within reason. Direct interosseous wiring, indirect wire suspension of loose fragments to the infraorbital and supraorbital ridges and pin fixation all have their limited indications.

FRACTURES OF THE MANDIBLE—Fractures of the mandible are more frequent and occur at any age. In young children, the location of the fracture line generally is in the anterior (mental or paramental) region where the mandible is thin and contains many tooth buds. The cuspid region is particularly susceptible to trauma for the cuspid is located at the anterior angle of the body of the mandible.

Fractures of the condyle are observed in extremely young children and usually

2. Kazanjian, H. V., and Converse, J. M. Surgical treatment of facial injuries. Baltimore, Williams & Wilkins Co., 1949. p. 54-84, 99, 100, 137-141.

are caused by a direct blow resulting from a fall in which the child lands on the symphysis. The amount and direction of displacement depends on the pull of the involved muscle groups, the location, direction and bevel of the fracture line, and is proportionate to the distance of the fracture line from the insertion point of the involved muscles.

After the diagnosis of a fracture has been made, a treatment plan is drawn up. The plan must not only be simple, effective, and require the least amount of cooperation from the young patient, but also must be practical, permit easy feeding and create no unusual discomfort. Reduction must correct the displacement, and adequate surgical rest must be given to the fractured parts by immobilization.

In certain cases, where displacement is nil or minimal and there is no discomfort or motion in the fracture line, simple rest without fixation usually will suffice. When an appliance is indicated, it should be one over which the patient has little or no control and one that cannot be interfered with readily.

The simplest means of fixation is by the use of wire ligatures with intermaxillary elastics. Ivy loops, Stout continuous ligatures and Kazanjian buttons all have their indications. Jelenko or Winter's arch bars also are helpful if enough permanent teeth are present in the arch. In young children below the age of ten, the dentition provides poor retention for the ligatures and does not afford enough strength to provide satisfactory attachment for the ligatures and intermaxillary elastics.

In cases where the displacement cannot otherwise be reduced and controlled, splints can be constructed. They are retained in position by cementing them to certain key teeth and ligating them to others, or on occasion they are retained by circumferential wiring. They are particularly useful in cases where there has been loss of bone continuity, since the splint will maintain the fragments in proper position until bone grafting can be done.

Cast or Acrylic Splints—The construction of a cast or acrylic splint is relatively simple. After the teeth have been cleaned of all debris and gross calculus, alginate impressions are taken of the upper and lower arch. If the displacement of the fragments is such that a one-piece impression cannot be obtained, sectional impressions are made. A centric bite is secured. Models are poured in stone and duplicated. The model of the lower arch is cut along the fracture line and the edge is trimmed to allow leeway for the repositioning of the sections against the upper model. The direction, location and bevel of the fracture line are studied in roentgenograms before the models are assembled. With the help of the bites and by a study of the occlusion, both sections are positioned against the upper teeth and are firmly luted into position with sticky wax. A stone base is poured against the assembly, and the models are mounted on the articulator. When the stone is hard, the restored occlusion is studied carefully and if any discrepancies or errors are present the assembled fragments are taken apart and reassembled.

When the corrected model is satisfactory, it is duplicated. The splint is designed on the assembled model in accord with the therapeutic requirement of the

individual case. A cast or acrylic splint can then be made. Eyelet loops, hooks, holes for wiring, prongs, knobs, reinforcement wires or attachments for plumpers are provided wherever necessary. When there have been extensive traumatic injuries with loss of bone and soft tissue, the displacement may be such that the splint has to be made in several sections and assembled in the mouth. The different sections are constructed in such a way that they can be united when the fracture is reduced in the operating room.

The clinical steps for the insertion of the appliance consist of the cementing or wiring of the splint into position when the fracture has been reduced. If sectional splints are used, the interlocking attachments are placed after the abutment sections are secured in place. Interproximal pins or screws are valuable adjuncts for the retention of the appliance. Waldron[3] advocates circumferential wiring of the splint, for this usually is the only reliable way to retain the splint in position for any length of time. Simple cementing usually is not sufficient to keep the appliance in place because of the short length of the crowns, lack of undercuts and limited number of teeth present in the arch. This method, although ideal in certain instances, has some disadvantages. The appliances are complex; their construction is sometimes difficult and always time-consuming; they are difficult to adjust and require a surgical procedure for insertion. They are bulky and usually not well tolerated by young children; however, they are indicated in complicated, compound, comminuted fractures where surgical intervention is required to reduce and immobilize the fracture.

Orthodontic Splints—A simpler method, and one that has a wide range of application for the average fracture in the child patient, is the use of the orthodontic type of splint (Fig. 2, below). It is effective, simple to construct, time-saving, well tolerated by the patient, and affords excellent retention and good immobilization of the bone fragments. Principles of orthodontics are used in the reduction and immobilization of the fracture, and orthodontic technics are applied in the construction of the appliance.

Stone working models are obtained first in the usual fashion. If the patient is cooperative, the bands can be made directly in the mouth, and this method results in the best possible fit. Band material of stainless steel is used. The gauge for the molar bands is 0.005 to 0.004 of an inch. A strip about 5 cm. is cut, welded to obtain a retention loop for the band former, S. S. White no. 155, right and left, and adapted to the tooth. After the band has been adapted, it is welded, the extremities are overlapped, and welded again. It is then festooned and burnished on the tooth with a band adapter. The occlusal margins are corrected to free the occlusion, the fit is checked carefully and the retention tested.

If the indirect method of construction is used, accurate fit is more difficult to achieve. The teeth to be banded are freed from the proximating teeth on the model with a thin saw blade and are contoured and smoothed. The bands are then constructed in a manner similar to that used in the direct method. If the impressions

3. Waldron, C. W.; Balkin, S. G., and Peterson, R. G. Fractures of the facial bones in children. J. Oral Surg. 1:215 July 1943.

are accurate, little difficulty will be found in fitting the bands in the mouth. After the molar bands are ready, the other teeth to be used as abutments are banded. When all bands are finished, the appliance can be completed on the model. If the patient is cooperative, the bands can be seated directly on the teeth and a compound impression taken with the bands in position. Thus an accurate model is made on which the construction, fit and alignment of the bands can be completed.

The directions of the buccal tubes must be determined accurately so that the arch is aligned with the cervical margin of the teeth. This is important in order to prevent tipping of the teeth. The labial arch is contoured on the master model to conform to a harmonious arch form after the displacement of the bone fragments has been studied and the arch wire has been bent according to the outline of the corrected arch form and occlusal plane. It must fit against the vestibular surfaces of the teeth at the gum line, otherwise the spring action of the arch will move the teeth when the fracture is reduced.

Fitted tubes are slipped over the end of the arch and are soldered or welded to the molar bands. If other bands are present, retention brackets or eyelet loops are soldered on the labial surface to facilitate ligation of the teeth to the labial arch. Auxiliary attachments such as springs, hooks for intermaxillary elastics, or plumpers to support the soft tissues can be provided. In the average case, only two molar bands and a labial arch are necessary. The remaining teeth are ligated to all available teeth in the usual fashion.

Local anesthesia usually is adequate for insertion of the splint although the uncooperative or very young child may require general anesthesia.

Some manual manipulation of the fragments may be necessary in order to place the arch into the tube if considerable displacement of the fragments is present. If the appliance has been constructed properly, the bone fragments are repositioned in normal occlusion when the appliance is in place.

The banded teeth with their brackets or loops, and all other available teeth are ligated to the labial arch.

For the comfort of the patient, little balls of wax or compound may be placed on the ends of the ligatures to prevent irritation of the oral mucosa.

Slow orthodontic reduction may be necessary when the treatment of the fracture has been delayed (Fig. 3, A). Split lingual arches are used for the reduction of the fragments (Fig. 3, B, C). The labial arch provides rigidity and is adjusted when the fracture has been reduced and proper alignment achieved. Movement of the fragments is obtained readily with intermaxillary traction.

The results obtained with this type of appliance are rewarding (Fig. 3, D, E). Fractures of several weeks' standing have been treated without open reduction. The fragments move into proper position and alignment in a few days with properly planned intermaxillary elastic traction or labiolingual arch wires. After 5 to 7 weeks, the appliance can be removed. If severe comminution is present, the appliance usually is kept in position as a fixation appliance for an additional period. Distinct advantages of the orthodontic splint appliance are that it permits early function, allows normal feeding, is conserva-

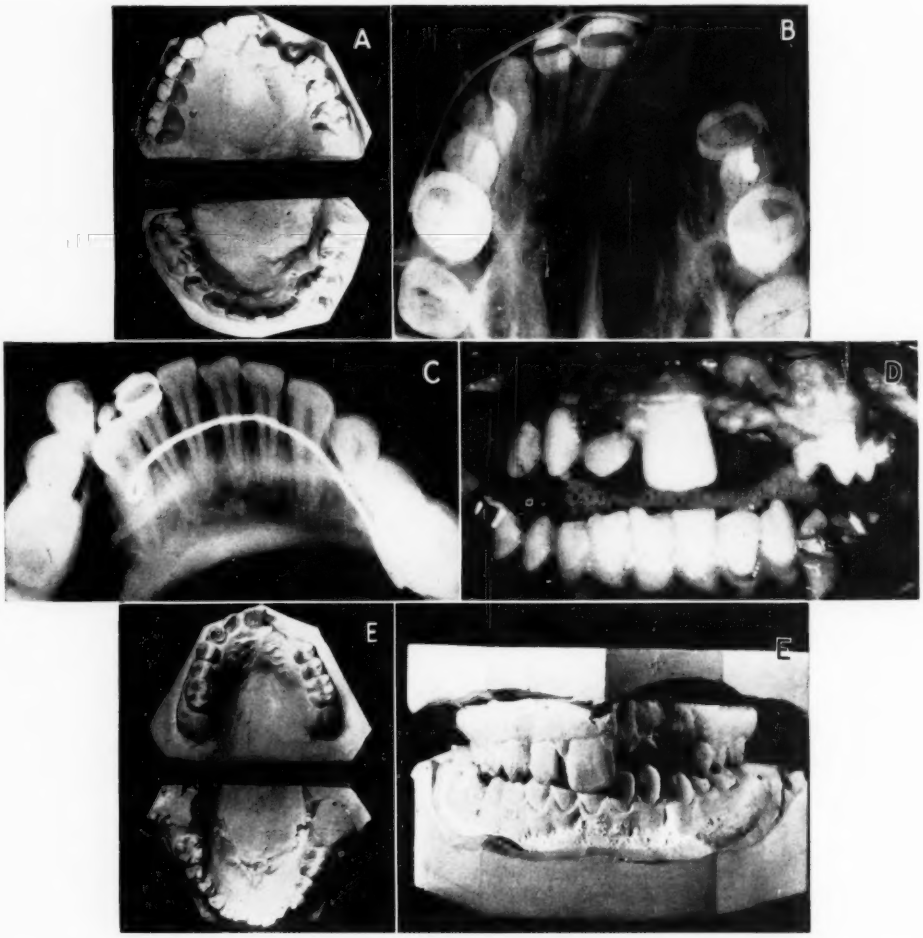

Fig. 3—An 11½ year old boy was struck by a car and sustained fracture of premaxilla with a loss of alveolar bone and upper left central incisors and cuspid as well as compound, bilateral fracture of mandible with severe overriding of fragments on left side and fracture in first molar region on right. Because of other injuries, dental treatment had to be deferred for two weeks. A: Models showing bone loss in maxilla, loss of teeth and severe displacement of left fragment which is displaced the width of a tooth. B: Upper orthodontic appliance in place with hooks for intermaxillary elastic traction. C: Occlusal roentgenograms of mandible showing section of lower orthodontic appliance in place and lingual arch used as spring appliance to bring right fragment forward and buccally by use of intermaxillary elastic traction. Fracture line and displacement are evident between left first bicuspid and cuspid. D: After five weeks of fixation. E: Postoperative models three months later. Occlusion and alignment of upper and lower dental arch are satisfactory. Patient is ready for construction of temporary prosthetic replacement for upper left anterior teeth

tive, has wide adaptability, is simple to construct, is nonirritating to the tissues, permits good control of retention forces and produces universally good results.

When an insufficient number of teeth are present so that it is impractical to use an orthodontic appliance or other means of fixation, open reduction and direct interosseous wiring has been advocated by some authors.[3] A modified technic of direct interosseous wiring which utilizes the intraoral approach and places the wires in the alveolar process has been described by Kazanjian and Converse.[2]

Secondary infection usually can be prevented by antibiotic therapy when open reduction has been carried out. Interosseous wiring alone may not be sufficient to give adequate rest to the bone fragments, and some additional form of immobilization may be necessary. It is a challenge to the ingenuity of the oral surgeon to plan a practical and effective treatment in such complicated cases. Extraoral pin fixation splints of the Roger-Anderson type are not practical for children and indications for their use are very limited.

■ *Comment*

The results obtained with the various methods of treating fractures in children are not always satisfactory. Incompletely reduced fractures lead to distortion, deviation of the bones and a crippled occlusion which, in children where growth is active, may lead to serious occlusal deformities. Occasionally, even when proper treatment has been instituted, normal occlusion may not be obtainable. Not much can be accomplished after the patient is an adult except by prosthetic treatment. For the child patient, however, there is a great deal that can be achieved by proper orthodontic therapy.

In addition to the usual knowledge and understanding of the management of traumatic dentofacial injuries in the adult, special consideration must be given if the successful treatment of these conditions in children is to be achieved.

■ Progress in Science

The most significant aspect of the present day in science is that we are going ahead energetically and accomplishing much. . . . It is far better that we should be embarrassed by the consequences of our rapid progress than that we should be bogged down to a snail's pace.—*Vannevar Bush, "We Are in Danger of Building a Tower of Babel," Public Health Reports 68:152 February 1953.*

Open reduction and internal wire fixation of maxillofacial fractures

■ *Reed O. Dingman, D.D.S., M.D., and Charles C. Alling,* D.D.S., M.S., Ann Arbor, Mich.*

Over 2,500 years ago Hippocrates stated the principles of the management of fractures. In essence these were: (1) to reduce and align the fractured bone segments, (2) to hold these bone segments in apposition until healing had taken place. These principles are as fundamental today as they were then; the primary objective in the management of fractures is the restoration of the damaged parts to normal function with the production at the same time of a satisfactory esthetic result. Normal mandibular function signifies a complete range of mandibular movements in all the usual planes with normal occlusal relationship. In fractures of the middle third of the face, to provide an adequate esthetic result, the contour of the facial features must be restored in continuity; to allow a functional result, anatomic repositioning of the maxillary alveolar processes and of the floor of the orbit must be achieved.

Fractures of facial bones have increased in severity and frequency with the advances in high speed transportation and destructive weapons. The complex nature of many of these fractures has complicated the methods of reduction and management. Fortunately, the improvements in management of patients, in anesthesia, in transfusion technics and in drug therapy have made possible the use of methods which could not have been employed even 25 years ago.

During the past few years the advent of the antibiotics and of chemotherapy has favorably influenced the development of new methods in the management of maxillofacial fractures. Complicated, cumbersome and uncomfortable intraoral and extraoral appliances have been superseded by the direct surgical approach. Extraoral appliances in most cases not only are uncomfortable but require close observation and frequent adjustment. Their construction and application are time-consuming, and the finished appliances are often ineffective.

The use of external appliances still has a limited place in the management of fractures of the maxillofacial region, particularly in sections where there is infection. In many cases, too, a simple appliance may save the patient a surgical procedure. If there is any question, however, of compromising the end result, the direct surgical approach should be used.

There are no two fractures of the facial bones which are exactly alike; the

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The opinions or assertions contained herein are the private ones of the writers and are not to be construed as official or reflecting the views of the medical service of the U. S. Army.

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details of management vary according to the displacement of the segments, the multiplicity of the fractures, the presence or absence of teeth in the mandible and in the maxilla and associated injuries.

Open operation offers clear access to the site of fracture and permits accurate reduction and positive fixation by direct wiring. This procedure can be accomplished with a minimum of armamentarium (Fig. 1). The methods are applicable to practically every type of facial fracture. Because of the accuracy and positive nature of the adjustment and the fixation, the patient requires a minimum of nursing and postoperative care. This procedure permits an early, inconspicuous return to active life (Fig. 2).

The same types of fractures are observed in the facial bony complex as elsewhere. These range from greenstick fractures to extensive comminuted, compound fractures. Because of the close attachment of the mucoperiosteum to the various anatomic cavities, the nose, the sinuses and the oral cavity, fractures involving facial bones may usually be considered compound fractures. The overlying mucoperiosteum is thin and almost always lacerated at the site of the fracture.

In all cases of accidents involving the facial region, a careful examination must be made to detect possible fractures. The fact that excellent results are obtained by the early management of fractures in this region in contrast to the disability and the deformity resulting from unrecognized, untreated maxillofacial fractures makes early diagnosis and treatment imperative. The complexity of the bony structure of the maxillofacial region often makes it difficult to detect fractures

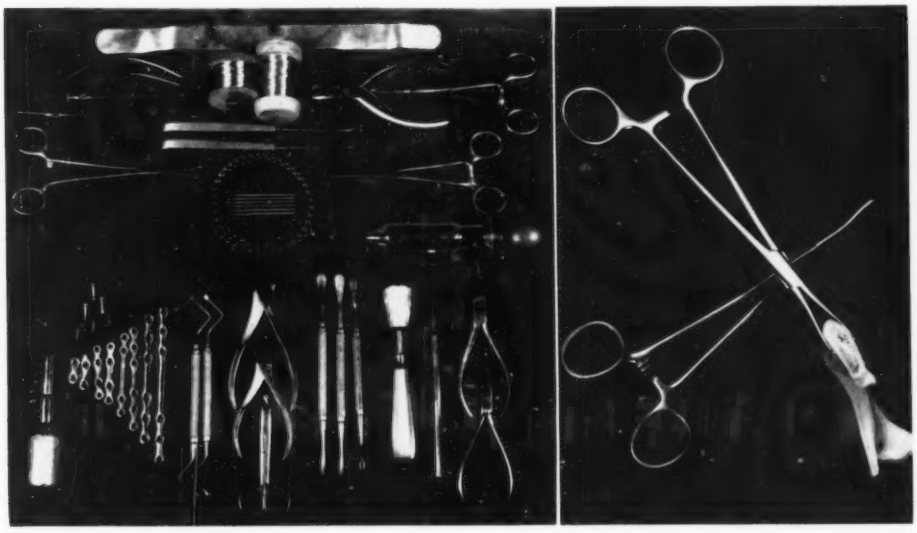

Fig. 1—Left: Instruments used in management of bony structures in maxillofacial surgery. Right: Modified bone-grasping forceps

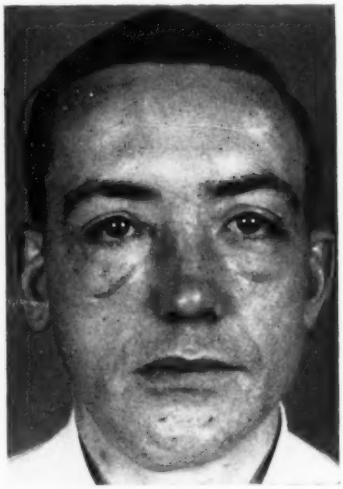

Fig. 2—Left: Preoperative view of patient after automobile accident resulting in bilateral depressed zygomatic fractures, nasal fractures and pyramidal fractures of middle third of face. Right: Postoperative view after open reduction of zygoma fractures at maxillary and frontal sutures, closed reduction of nasal fractures, and bilateral internal craniofacial suspension from zygomatic processes of frontal bones

during the acute phase of trauma, when edema, ecchymosis and soft tissue injuries make adequate examination difficult. Diagnosis of facial fractures is based on inspection, bimanual palpation and roentgenographic examination. A careful check should be made for irregularities, asymmetry or crepitation of the bony structures. An elongated face with a depressed maxilla indicates fractures of the middle third of the face. A "dishface" appearance is due to fracture and posterior displacement of the maxilla, especially if the nasal bones are involved (Fig. 3). The examiner usually can detect fractures of the maxilla, unless they are impacted, by grasping the upper anterior teeth and noticing the extent of mobility when movement is attempted in various directions. Bimanual palpation of the orbital margins and palpation of the nasal bony processes may lead to the detection of fractures of these structures.

One of the most important clinical signs in the detection of fractures of the facial bones is malocclusion. If the teeth do not occlude properly, a fracture should be suspected. Other symptoms, such as pain, tenderness, disability, deformity, swelling, discoloration, crepitation, abnormal mobility, excessive salivation and fetor oris, also may be helpful in establishing a diagnosis.

Regardless of the skill and experience of the operator, no final diagnosis or treatment should precede adequate roentgenographic studies. Roentgenographic films are an invaluable adjunct to other diagnostic procedures and should include stereoscopic anteroposterior and lateral views of the skull, facial bones and mandible with detailed studies of the temporomandibular joint regions when indicated. If fractures of the middle third of the face are suspected, films taken in the Waters' position and other special views should be obtained to bring out the contour of the zygoma, the zygomatic arch, the maxilla and the nasal bones. Intraoral roentgenographic examinations

with periapical and occlusal films are often helpful.

■ *Time of Treatment*

Although it is desirable to treat maxillofacial fractures at the earliest possible moment, these fractures should never be considered as acute surgical emergencies. The patient's general condition must receive prior consideration, and active measures for the control and correction of shock, insurance of an adequate airway, and prevention of hemorrhage are paramount. Evaluation of the patient's physical status should include examination by a neurosurgical consultant. The fractures should be treated as soon as possible after clearance from the consultant.

■ *Anesthesia*

After adequate premedication with barbiturates, morphine or substances with a similar action, administered in conjunction with atropine or scopolamine, many of the less severe injuries can be treated under local anesthesia. The advantage of such treatment, when it can be used, is that there is no need to employ a general anesthetic with its attendant problems.

In extensive fractures, however, it is easier for both the operator and the patient if the procedure is carried out under general anesthesia. Under general anesthesia it is advisable to insure the patency of the airway by the introduction of an intratracheal tube.

Because operations in the facial region may cause both neurogenic and hematogenic shock, patients should receive a blood replacement during the course of the operative procedure.

■ *Fractures of the Mandible*

If the teeth are adequate for intermaxillary fixation, open reduction methods

Fig. 3—Left: "Dishface" appearance, one year after injury, caused by unreduced fracture of middle third of face. Right: Appearance after osteotomy of maxilla

are usually unnecessary for the management of fractures of the body of the mandible. If the teeth are severely damaged and do not permit intermaxillary fixation or if they are otherwise inadequate, open reduction and direct wiring usually give results superior to those achieved solely by fixing splints or dentures to the mandible with circumferential wires or by other closed reduction methods using external appliances.

It is preferable to combine the two technics when practicable, that is, to supplement the open reduction procedure with a closed reduction technic (Fig. 4). Where there is interposition of soft tissue, open reduction permits direct approximation of the bone at the site of fracture by means of positive fixation. Open reduction can be achieved with a minimum of effort and equipment, a maximum of accuracy and little subsequent disability for the patient. It eliminates the need of resorting to the use of complicated, cumbersome splints or external pin fixation appliances.

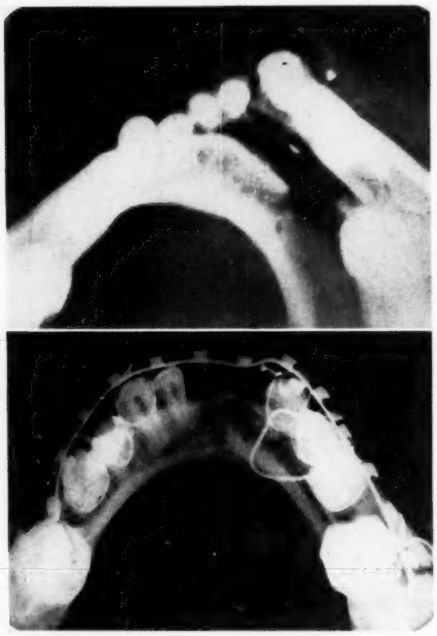

Fig. 4—Preoperative and postoperative mandibular occlusal views of oblique, angular, compound, comminuted fracture of mandible. Methods of fixation were open reduction with direct wiring lateral to right molar, circumferential wiring in right mental region, and a labial arch bar. Actual reduction and approximation of fracture were accomplished under direct vision through a submental approach. Mandible was immobilized against maxilla during treatment

In multiple facial fractures, especially those involving the maxilla, accurate reconstruction of the mandible by open reduction methods makes it possible to use the mandible as a guide for the establishment of normal maxillary position.

Fractures through the angle of the mandible distal to the most posterior tooth are especially difficult to manage because of the upward and medial displacement of the proximal fragment by the muscles of mastication. Various appliances and methods have been employed for the reduction, approximation and fixation of the fragments of the bone in fractures of this type. Intraoral appliances include bite blocks, which are used to hold the proximal segment downward and posteriorly, and intraoral splints with a projection extending posteriorly to engage the proximal bone segment and to prevent its displacement.

Another method often described is the use of a head cap with a wire passed through the angle of the mandible to pull the posterior segment downward and posteriorly. None of these appliances and methods assure consistently excellent control of the proximal fragment. The authors

have found that the most satisfactory method of fixing such fractures is an open reduction at the site of fracture. This reduction is simply accomplished by making a small incision below the inferior border of the mandible and by wiring the bone fragments directly across the site of fracture with stainless steel wire through small drill holes in the bone (Fig. 5).

Although uncommon, cases of fracture of the coronoid process of the mandible are observed occasionally (Fig. 6). There may be upward and medial displacement due to the pull of the temporalis muscle. In the majority of such cases, however, because of the dense surrounding periosteal and muscular attachments, the displacement is minimal. In some cases fractures extend from the sigmoid notch downward into the ramus toward the angle of the mandible. These, too, are so well splinted with muscular attachments that the displacement is minimal; in most cases no treatment other than intermaxillary fixation is required. If there is a moderate degree of separation of the fragments, open reduction is the method of choice.

Fractures through the neck of the mandibular condyloid process present difficult problems, since they may be associated with dislocation of the condyle from the glenoid fossa, overriding of fragments or interposition of soft tissues. Failure to reposition the condyle and to fix it in position accurately may compromise results and cause a deviation of the mandible to the affected side on opening, inadequate opening of the mandible, or ankylosis. It is true that excellent results are usually obtained by conservative management of such fractures. This management generally consists simply of wiring the teeth together accurately and holding them in this position for three or four weeks.

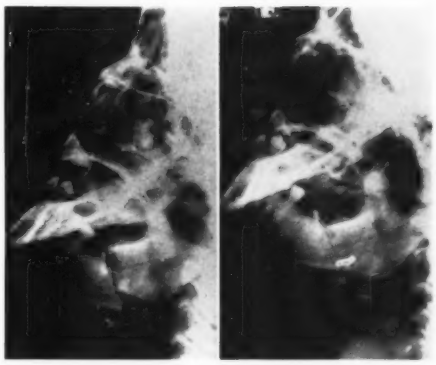

Fig. 5—Preoperative and postoperative lateral views of fracture of angle of mandible. Open reduction was accomplished by transosseous wiring

According to Henny[1] in fractures of the neck of the condyloid process involving displacement of the proximal fragment, poor results can be expected when the patient's teeth do not provide adequate dentition for fixation, when there is bony impaction, or when there is interposition of soft tissues at the fracture site. In such cases there usually is displacement of the mandible toward the affected side because of muscle pull; especially in cases where posterior teeth are lacking, this displacement may be considerable. During the past few years the authors have performed open reductions in a large number of such cases. The best approach for an open reduction is usually through the submandibular incision of Risdon,[2] since the alter-

1. Henny, F. A. A technic for open reduction of fractures of the mandibular condyle. J. Oral Surg. 9:233 July 1951.

2. Risdon, F. E. Ankylosis of the temporomaxillary joint. J.A.D.A. 21:1933 Nov. 1934.

nate approach, the preauricular incision, often does not provide adequate access to the site of the fracture without the possibility of damage to the facial nerve.

Before attempting an open reduction on the neck of the condyloid process, the operator must decide whether he will secure a better functional result with the direct approach than he would with conservative management. The possibility of injury to the facial nerve and to the meniscus and condyle must be considered carefully.

The incision is made 1 cm. below the angle of the mandible and about 5 cm. in length. The angle of the mandible is exposed by careful dissection to avoid any low cervical or mandibular branches of the facial nerve. The insertion of the masseter muscle is incised and the muscle retracted from the bone. By the use of long narrow-angle retractors the fracture site can be exposed. With a bone bur mounted in a dental handpiece, a small hole is drilled in the distal fragment just below the site of fracture. A length of no. 25 gauge stainless steel wire is passed through this hole, and the wire is used for downward retraction. This procedure will provide access to the upper segment of bone.

At this stage it may be advantageous, as Henny[1] points out, to give 60 to 90 units of curare intravenously to provide

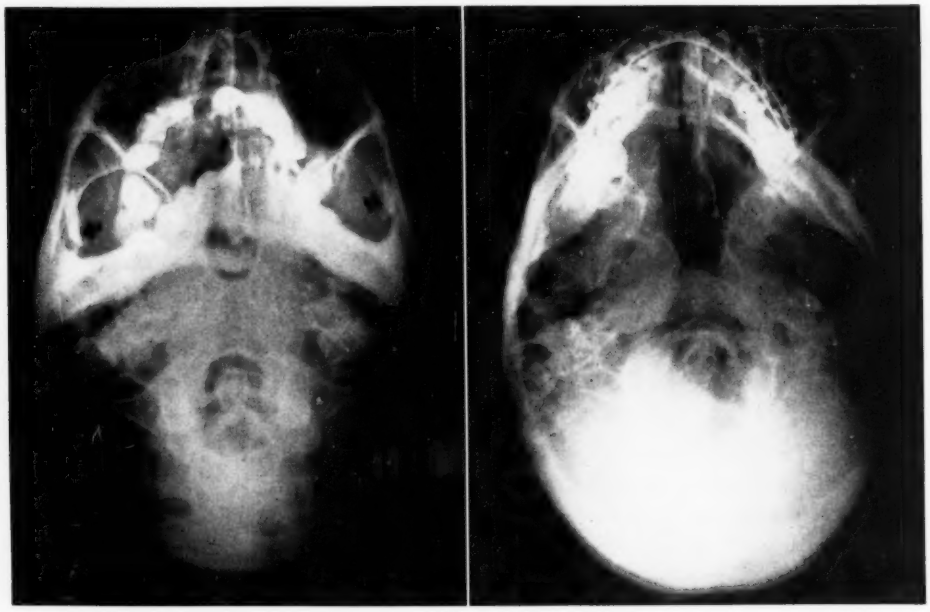

Fig. 6—Basilar views of mandible showing typical displacement in fractures of coronoid processes. In this case no surgical interference was instituted for coronoid process fractures, and no disability resulted. Also shown are bilateral transverse maxillary fracture, treated by internal suspension, and compound mandibular symphysial fracture, treated by open reduction

relaxation of the external pterygoid muscle. When it is necessary, the external pterygoid muscle is severed from the condylar and mandibular attachments to permit repositioning of the condyle in the mandibular fossa and to prevent subsequent dislocation muscle spasm. The proximal segment is best managed by grasping it with a small bone forceps or an Ochsner forceps. The operator is then looking upward into a long tunnel, so that it is difficult to drill a hole in the upper segment. The drilling can be accomplished by passing the drill through the skin and soft tissues of the cheek overlying the condyle region so that the bur can engage the proximal fragment at the correct angle.

The inner arm of the retraction wire is passed through the drill hole in the proximal segment, and the ends are twisted tightly into a knot on the lateral surface. The ends of the wire are cut and pressed against the bone. The wound is closed in layers with catgut or silk and Dermalon sutures. If teeth are present, intermaxillary fixation is indicated for additional stabilization (Fig. 7).

■ *Alveolar Fractures*

Segments of the alveolar process may be fractured separately or in association with fractures of the body of the bone. In the case of complete fractures of the alveolar process, if there has been an avulsion of the process from the surrounding periosteal tissue, the bone fragments usually cannot be saved. In most instances it is best to separate the loose bone fragments from the small periosteal attachments and to close the soft tissue over the remaining bone. In the case of a fracture

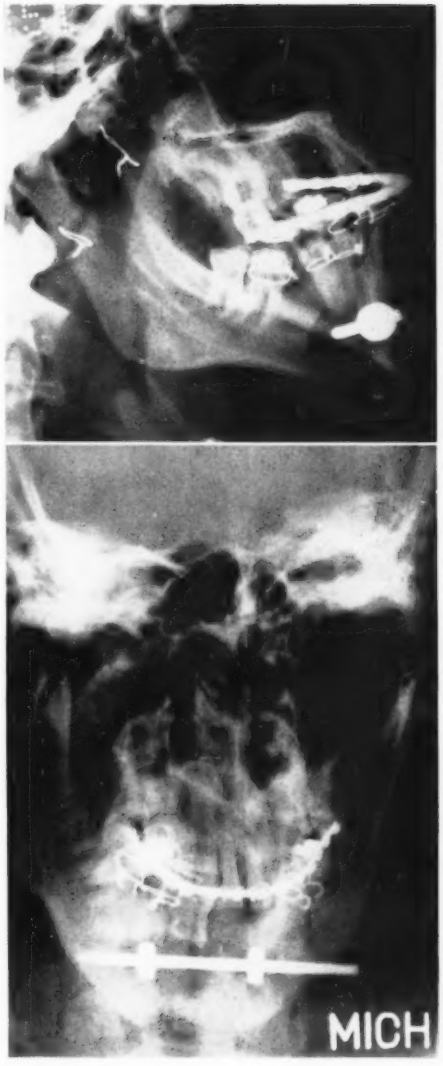

Fig. 7—Bilateral fractures of neck of condyloid process, reduced by open reduction and direct wiring. Modified Steinmann pin was used to hold lateral fragments of mandible in anatomic position, since there was loss of bone in symphysial region

where the periosteal attachments have been maintained, it is possible in some

cases to save the alveolar bone and teeth by fixation with dental appliances, arch bars, splints, circumferential wiring or interdental wiring.

■ *Fractures of the Maxilla*

The principle of internal wiring fixation of facial fractures, as described by Adams[3] in 1942, has been of invaluable aid at the University of Michigan in the management of extensive facial fractures. In the clinic the use of this method has virtually eliminated the employment of external craniofacial fixation appliances. External appliances cannot be completely eliminated, however, since there are certain instances in which internal wire fixation does not answer the entire problem, especially when the need arises for forceful traction in anterior or lateral planes.

The complete bilateral transverse fracture of the maxilla through the lateral and medial maxillary walls just above the level of the teeth and through the base of the nasal septum usually can be detected by the presence of malocclusion and by the mobility of the maxillary segment. In cases of impaction, however, it may be somewhat difficult to ascertain, as roentgenographic examination of fractures of this region is frequently inconclusive. If the mandible is not fractured, the normal position of the maxilla can be determined quite easily by moving the maxilla into a position of normal occlusion with the mandibular teeth. Intermaxillary rubber band fixation supported on maxillary and mandibular labial arch bars or continuous loop wiring will maintain the occlusal relation of the teeth.

In the support of the mobile maxilla, internal craniomaxillary wire fixation eliminates cumbersome, uncomfortable external appliances. This procedure is accomplished by the method of Adams[3] through bilateral, infraorbital incisions with the exposure of the infraorbital bony

3. Adams, W. M. Internal wiring fixation of facial fractures. Surgery 12:523 Oct. 1942.

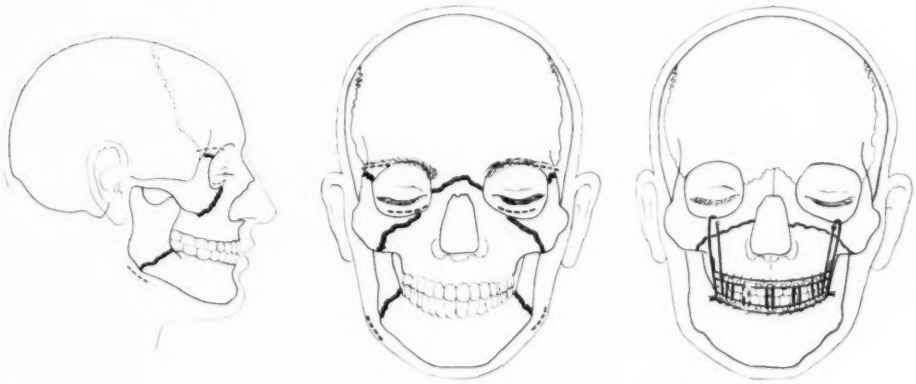

Fig. 8—Left and center: Internal craniomaxillary wire fixation. Dotted lines show sites of cutaneous incisional approaches to fractures of maxillofacial bony complex. Right: Internal wires supporting mandible and reducing maxillary fracture

margin (Fig. 8, left and center). A small hole is made with a bone bur starting about 4 mm. below the infraorbital margin and passing upward and posteriorly into the floor of the orbit 3 to 4 mm. behind the orbital rim. No. 25 gauge stainless steel wire is threaded through this hole in the bone and looped over the ridge. Both ends of the wire are then passed through the soft tissues in the canine fossa, either attached to a large needle or passed through a large hollow needle to emerge through the buccal vestibule in the region of the bicuspid teeth. One wire is passed around the lower arch bar on each side.

An assistant places upward traction on the mandible, bringing the maxilla into normal relation with the superstructures. The ends of the wire are then twisted tightly around the lower arch bar, and the wires are cut short enough that the wire ends can be turned back against the surface of the teeth to prevent soft tissue irritation. This procedure provides positive fixation of the mandible, which in turn supports the maxilla in an anatomical position for repair at the fracture lines (Fig. 8, right and 6, right). Fixation is maintained for a period of three to four weeks, depending on the severity of the fracture. The wire through the infraorbital margin can generally be removed without difficulty by cutting the wire, grasping one end and pulling it out through the mouth. The mouth should be cleansed thoroughly and carefully before this procedure is initiated. It may seem unwise to pull the wires from the mouth through the soft tissue in this manner, but the authors have never observed any complication resulting from this procedure. In some cases, however, it is necessary to reopen the infraorbital incisions under local anesthesia for removal of these wires.

Common lines of fractures of the facial bones can be approximated by direct wiring through 1.5 cm. incisions at the ends of the superciliary ridges to expose the zygomaticofrontal suture and through the infraorbital fold to expose the infraorbital rims and zygomaticomaxillary sutures. The fractured bones are held in position by wiring them directly to the adjacent stable unfractured structures.

In the pyramidal type of fracture involving the nasal bony process without fracture of the zygomatic bones, it is possible to perform an open reduction with direct wiring of the bones at the infraorbital margin. If this support is not sufficient, wires can be passed from the stable lateral orbital rim of the zygoma to an arch bar on the upper teeth. To prevent or correct downward displacement of the posterior portion of the maxilla, incisions are made in the lateral aspect of the superciliary ridge on both sides, and a small drill hole is cut through the bone rim just above the zygomaticofrontal suture. A no. 25 gauge stainless steel wire is passed through the hole in the bone, and both ends are then passed through a large bore guide needle behind and medial to the zygomatic arch to enter the mouth in the region of the maxillary second molar (Fig. 9, left). One end of the wire is passed around the maxillary arch bar, and the ends are grasped with a hemostat. The maxilla is brought up into correct relation and held there by twisting the wires about the arch bar (Fig. 9, right). This method provides positive fixation of the entire

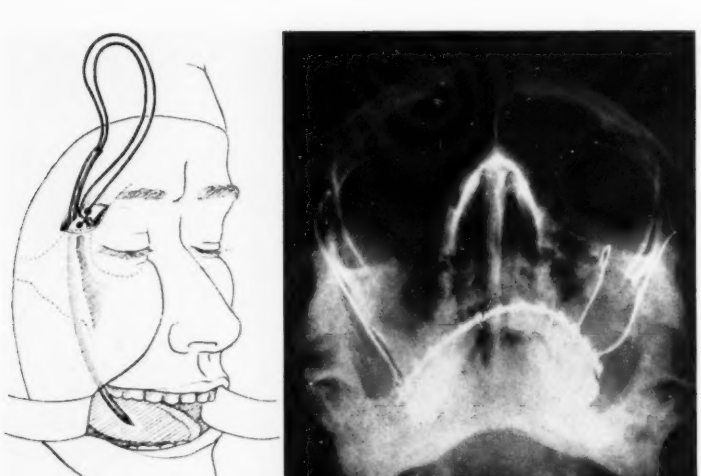

Fig. 9—Left: Passing of internal craniofacial suspension wires through hollow needle posterior and medial to temporal process of zygoma. Open reduction is depicted at zygomaticofrontal suture. Note that suspensory wire passes through hole in frontal bone. Right: Waters' view of open reduction of bilateral zygomaticofrontal fractures and three-point internal craniomaxillary suspension

maxillary segment. Even if the mandible is not fractured, experience has shown that fixation of the mandible to the maxilla provides a guide for the accurate positioning of the maxillary segments.

In the more extensive zygomaticomaxillofacial compound fracture, the zygomaticofrontal suture is usually involved in the fracture (Fig. 10). Reconstruction should be started in this region through small incisions at the lateral ends of the superciliary ridge on both sides. The zygomaticofrontal suture is directly approximated by a no. 25 gauge stainless steel wire passing through small drill holes on each side of the separated suture. The upper of these holes can be used also to carry a wire behind the temporal surface of the zygomatic bone into the vestibule of the mouth for support of the posterior portion of the maxilla (Fig. 9, left). Such a fracture is often associated with a fracture at the zygomaticomaxillary suture and necessitates exposure through incisions in the infraorbital region and direct wire fixation (Fig. 11). Fixation at the zygomaticotemporal suture line is usually unnecessary, as the bones will remain in position after reduction because of the bulging of the temporalis muscle.

■ *Zygomatic Fractures*

The zygoma is generally fractured at the zygomaticofrontal, zygomaticomaxillary and zygomaticotemporal sutures with downward and posterior displacement. Reduction can usually be obtained by the conventional methods of applying force

upward and forward on the temporal surface of the zygoma. Without fixation, displacement may recur because of the pull of the masseter muscle.

At the University of Michigan in a number of cases where the fracture seemed to be adequately reduced at the time of the operation performed by conventional conservative means the results were disappointing. Though roentgenographic examination showed what appeared to be adequate reduction, in some cases there was flatness of the zygomatic region and depression of the infraorbital rim after all the ecchymosis and edema had subsided. For that reason exploratory operations were performed. After the fracture seemed to be adequately reduced by the usual methods, the sites of fracture were exposed, and frequently a displacement of several millimeters was observed. Thus it is not always possible to determine adequate reduction by clinical and roentgenographic examination. For this type of fracture, therefore, at the University of Michigan, it has become almost routine to perform an open reduction at the frontal and maxillary sutures and to employ direct wiring (Fig. 12).

■ *Nasal Fractures*

In some instances it appears expedient to use open reduction with direct wiring of the nasal process of the maxilla and the nasal bones to the nasal process of the frontal bone. This procedure may be advisable in the pyramidal type of fracture of the maxillary nasal complex involving separation of bone at this suture.

The lacrimal and ethmoid bones are often involved in fractures of this region, and particular care should be taken to replace these bony processes. If it is not done, it may be found after healing has taken place that the nose is excessively broad because of lateral displacement of

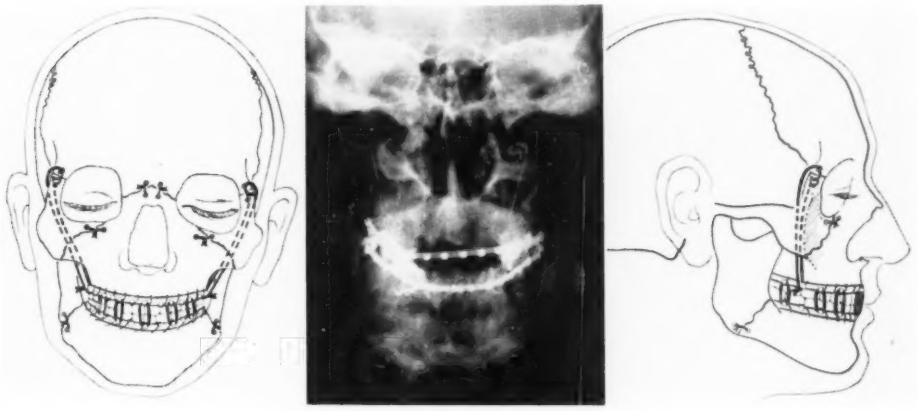

Fig. 10—Left and right: Suspension of extensive facial bone fractures by internal wires from zygomatic process of frontal bones. Mandible has been reconstructed by bilateral open reduction and is being used as guide for positioning maxilla. Center: Open reduction of zygoma, bilateral mandibular open reductions and four-point internal wire suspension

the nasal and lacrimal bones. The resulting appearance is undesirable because of the unusual breadth of the nose and the abnormal distance between the medial canthi. Correction can be made only by osteotomy and open reduction for the replacement of these bones and the reattachment of the medial canthal ligaments to the lacrimal crest.

Most recent nasal fractures can be reduced adequately by the repositioning of the septum with the Ash forceps and by upward and outward intranasal pressure on the nasal bony processes with digital external manipulation. Various types of intranasal splints are useful in supporting the nasal bony processes. Adequate support can be provided by the use of intranasal Vaseline gauze packs for a period of three to five days and a metal splint for external support.

■ *Fractures with Loss of Bone*

In cases of fractures where there is either severe comminution or actual loss of bone segments, it is unwise to attempt reconstructive procedures until the soft tissues have healed completely. Every effort should be made to maintain the remaining bone fragments in as nearly normal position as possible. In many cases this position can be maintained by intermaxillary fixation with rubber bands or by direct wiring of the remaining bone fragments to the teeth in the upper jaw. In some cases acrylic splints, tantalum bars, Kirschner wires or Steinmann pins may be of help in maintaining the position of

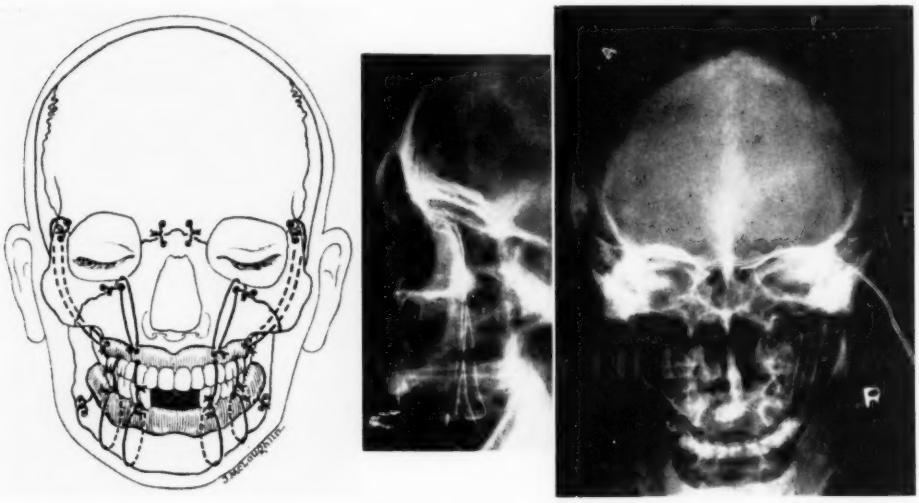

Fig. 11—Left: Use of dentures to establish correct anatomic positioning and to provide a basis for internal wire suspension. Note circumferential mandibular wires and intermaxillary wires placed through dentures. Center and right: Complex fractures of facial bones of edentulous patient. Fractures were reduced by direct wiring and internal wire suspension, providing support with maxillary denture to immobilize fractures of facial bones

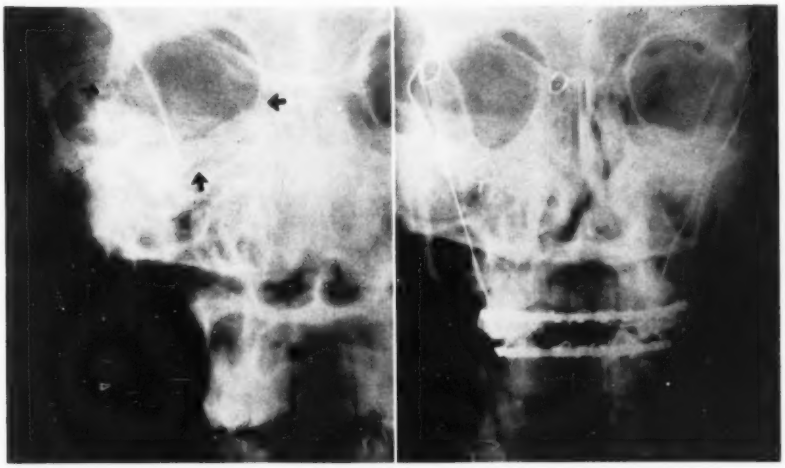

Fig. 12—Preoperative and postoperative views. Treatment consisted of open reduction of zygomatic fracture combined with internal wire suspension for maxillary fracture

the remaining bone fragments until the bone grafting procedures can be undertaken (Fig. 13). If the remaining bone segments are not adequately splinted, scar tissue may cause displacement of the bone segments and make reconstructive problems difficult.

■ *Fractures with Loss of Soft Tissue*

When fractures occur as a result of high velocity missiles, there is generally a loss of large amounts of the soft tissue which ordinarily covers the bone structures. In these cases in addition to adequate splinting of the remaining bone fragments, every effort must be made to cover the bone ends with soft tissue in order to provide the bone with an adequate blood supply and to prevent the formation of scar tissue over the ends of the bone fragments.

If bone segments are permitted to remain without soft tissue coverings, sequestration may result and complicate the reconstructive procedures. The fractured bone ends may be covered by elevating the adjacent mucoperiosteal flaps and sliding them into position over the bone ends or by constructing pedical flaps of soft tissue from the immediate vicinity and advancing them over the bone ends to provide protection against infection and to give an adequate blood supply for nourishment of the bone.

■ *Duration of Fixation*

The duration of fixation varies with the individual case and depends somewhat on the extent of the fractures, the accuracy of the approximation and the age of the patient. In the uncomplicated fracture where the bone ends can be approximated accurately, four to five weeks of fixation generally is sufficient to permit clinical union. There may be some

springiness at the site of fracture after this length of time, but the union is usually sufficient to permit partial function.

When there is extensive comminution and actual loss of some bone structure, fixation necessarily must be maintained for a greater length of time to permit clinical union of the bone fragments. In cases where there is loss of bone and soft tissue, fixation must be maintained until after reconstructive procedures have been carried out for replacement of soft tissues and bone structures. Fixation in these cases may necessarily extend to a period of a year or two.

■ *General Care of Patients*

The general care of patients with fractures of the facial bones ordinarily should consist of the therapy considered desirable for any other traumatic case. First aid methods include control of hemorrhage, establishment and maintenance of an airway, and the prevention and treatment of shock. Sedation is advisable if a patient is uncomfortable. If it is not pos-

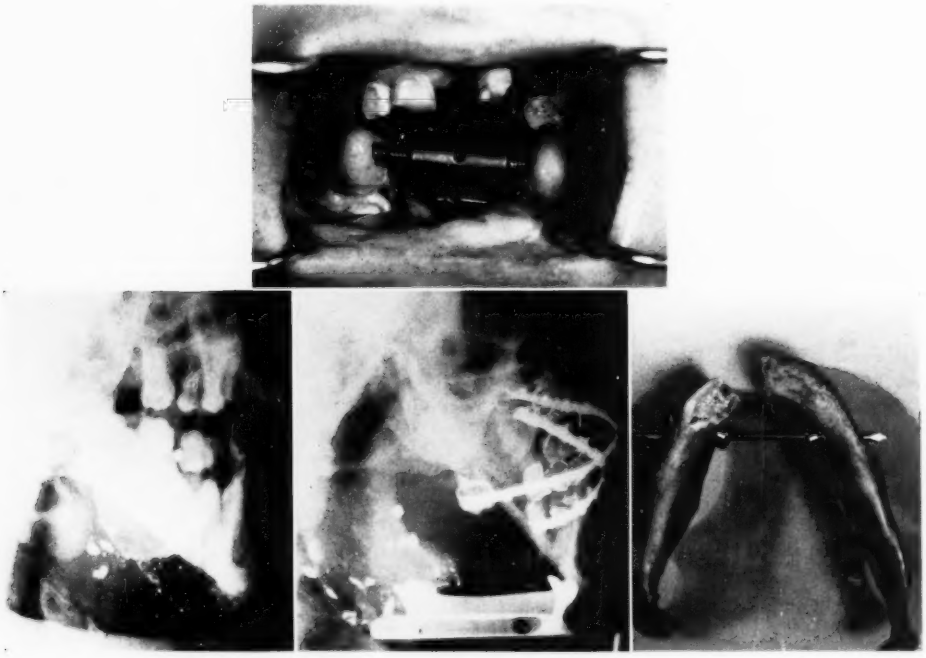

Fig. 13—Above: Intraoral acrylic splint with jackscrew maintaining anatomic positions prior to bone grafting. Loss of anterior mandible was result of gunshot injury. Below left: Preoperative view of loss of mandible after gunshot injury. Below center: Postoperative view of mandible with tantalum splint maintaining anatomic positions of mandibular fragments before bone grafting. Below right: Steinmann pin, used to maintain anatomic relations after loss of bone by gunshot injury. Lugs are adjustable on shaft of pin and are maintained in position with set screws. Figure 7 demonstrates use of this pin

sible to effect immediate reduction, support by head bandages may make the patient feel more comfortable.

Inasmuch as most fractures of this type are compound fractures, the usual antibiotics should be given in adequate doses to prevent infection. Early ambulation should be encouraged.

The local care of the soft tissues is extremely important. If it is not possible for the patient to brush his teeth several times a day, mouthwashes should be used. A weak solution of hydrogen peroxide in water in a dilution of 1:4 is helpful in removing mucus from the mouth and in breaking up blood clots that may become lodged in the oral cavity. A 50 per cent solution of essence of Caroid also is useful. This is a vegetable digestant which keeps the mouth free from accumulations of food and mucus. Any pleasant-tasting mouthwash helps the patient maintain good oral hygiene.

Blood transfusions are indicated when there has been considerable loss of blood. In some cases hematopoietic drugs are advisable and should be given during treatment.

The most important single factor in the general care of the patient with a fractured jaw is diet and fluid balance. It is never necessary to extract a tooth to maintain adequate nourishment for a patient with a fractured jaw, even if he has a full complement of teeth. There is enough space between the teeth and around the distal ends of the dental arches to permit the ingestion of adequate nourishment.

Patients should be maintained on a high-caloric, high-vitamin, high-protein, liquid diet. If possible a dietitian should be consulted, since considerable ingenuity is necessary to keep the diet varied and attractive for the patient. The diet should contain between 2,500 and 3,500 calories a day depending on the size and activity of the individual patient. The use of a mechanical food liquidizer simplifies considerably this aspect of the management of fractures.

Fig. 14—Left: Diplopia resulting from untreated depressed fracture of right zygoma, incurred in automobile accident. Right: Postoperative view after osteotomy and open reduction of surgically mobilized zygoma restored balanced ocular function and provided acceptable esthetic result

■ *Complications*

Osteomyelitis following the fracture of the mandible is an infrequent complication, although until the advent of anti-

biotics and sulfa drugs, over 20 per cent of mandibular fracture cases were complicated by osteomyelitis. Malunions of the facial bones usually can be managed by osteotomy followed by fixation of the fragments in normal position (Fig. 2 and 14). Cartilage and bone onlays have been used successfully to restore facial contours.

The problem of nonunion can be overcome by exposing the site of fracture and removing the interposed soft tissues. The removal of soft and fibrous tissue from the site of fracture with adequate approximation of the bone ends generally results in adequate healing. In some cases it is necessary to expose the involved region and to repair it with iliac bone grafts in order to stabilize the mandible.

■ *Summary*

Open reduction and internal wire suspension provide a means of accurate, complete fixation and immobilization of fractures of facial bones. The advantage of open reduction is that it eliminates the need for cumbersome, unsightly external appliances and complicated intraoral splints. Open reduction of facial bones is possible through cutaneous incisions in inconspicuous locations. The mandible is essential as a guide for repositioning in cases of fractures of the middle third of the face; and if the mandible is fractured, its reconstruction should precede reduction of fractures of the middle third of the face.

Roentgenographic technic and interpretation in fractures of the jaws and facial bones

■ *H. F. Doane, D.D.S., Detroit*

The roentgenographic method of examination is indispensable in the diagnosis of fractures of the jaws and facial bones; however, it cannot be depended on as the sole source of information. A complete diagnosis must be based on a correlation of the roentgenographic observations with data obtained from the patient's history, the physical examination and a thorough clinical examination of the involved structures.

Certain basic views are required for examination of the bones of the face and mandible. Later it may be desirable to supplement the original roentgenograms with others made by moderate variation of the technic or with special projections to demonstrate certain structures more

efficiently. With one exception the Potter-Bucky diaphragm is used in the extraoral technics to be described because of the greater contrast and definition possible in the roentgenograms. The vertical apparatus illustrated herein permits the patient to sit erect and thus less pressure is exerted on the injured regions, which in turn causes less discomfort to the patient during the examination. This apparatus is used routinely except in those instances in which the horizontal position is required because of the general condition of the patient. However, the positioning of the patient's head in relation to the film and the central ray is the same in either event.

■ *Examination of Facial Bones*

The recommended basic views for examination of the facial bones are:

POSTEROANTERIOR CHIN-NOSE POSITION—In the posteroanterior chin-nose position the cassette holder is inclined 15 degrees caudally (Fig. 1, above). If the patient is in a horizontal position, this inclination is toward the floor or below horizontal. With the patient facing the film and the head resting on the chin and nose, the position of the head is adjusted so that the median plane is vertical and centered to the midline marked on the cassette holder. The Potter-Bucky diaphragm is adjusted so that the nasion is centered to the midpoint of the film. The head is then immobilized with a clamp or suitable strap. In order to illustrate the relation of the head to the cassette holder, the clamp employed is not shown except in Figure 10. The central ray is directed horizontally so that it enters the vertex midway between the zygomatic arches and through the nasion.

This view shows the zygomatic arches, zygomatic bones, infraorbital ridges, antronasal and lateral walls of the maxillary sinuses, nasal septum, frontal sinuses, the lateral and, to some extent, the medial and superior walls of the orbits.

Figure 1, below, is an illustration of this view and shows a depressed fracture of the left zygomatic bone with separation of the zygomaticofrontal suture and depression of the lateral wall of the orbit. Fractures that involve the lateral wall of the maxillary sinus and infraorbital ridge, with displacement of the fragments at both sites, are also evident. There is considerable clouding of the left maxillary sinus because the cavity is filled with blood. Since the injury is unilateral, excellent contrast can be obtained with the opposite side.

LATERAL PROJECTION—For the lateral projection the side of the face to be examined is placed toward the film resting on the zygomatic bone, which is centered to the midline marked on the cassette holder (Fig. 2, above). The head is then adjusted so that its median plane is parallel to the plane of the film, a line between the pupils of the eyes at a right angle to the film and a line through the long axis of the zygomatic arch parallel to the transverse axis or lower border of the film. The central ray is directed at a right angle to the film through the zygomatic bone. This gives a lateral view of the skull and facial bones with the two sides superimposed and is especially useful to show injuries that involve the frontal sinuses and cribriform plate.

Frequently it is advantageous to combine views in order to obtain an adequate study of a region where a fracture is suspected. An example of such a situation is illustrated in Figure 2, below, where the posteroanterior chin-nose projection (Fig. 2, below left) reveals bilateral fractures of the maxilla with displacement of the fragments at the superior aspect of the lateral wall of each maxillary sinus. Both antrums are clouded because of hemorrhage that followed the injury. There is an indistinct line of decreased density across the anterior region of the maxilla that suggests a horizontal fracture. The lateral projection (Fig. 2, below right) shows a fracture line that extends across the entire anteroposterior dimension of the maxilla. This view confirms the horizontal fracture that was suspected from

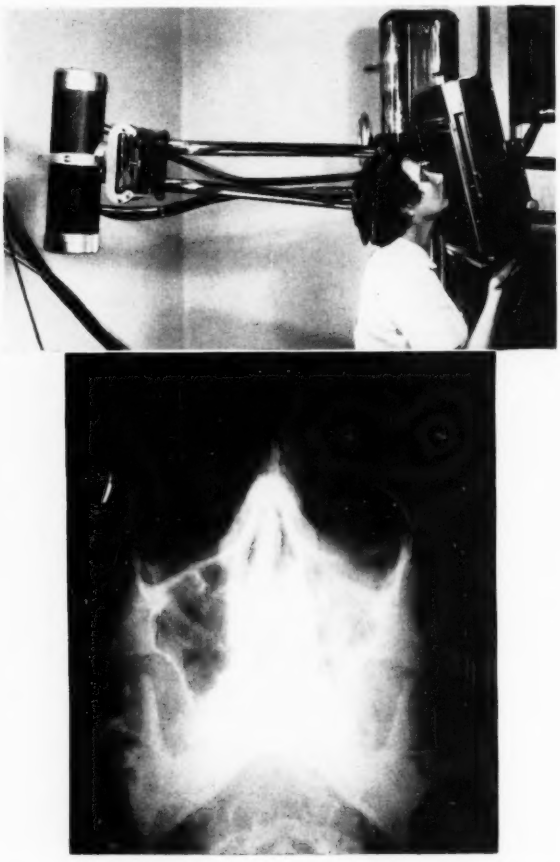

Fig. 1—Above: Posteroanterior chin-nose position. Below: Posteroanterior chin nose projection. Fractures of left facial bones

the other view. There is a single line of fracture that appears comminuted because of the superimposition of the two sides. In this projection it also can be ascertained that the maxilla is displaced posteriorly and the upper incisors protrude as a result of the trauma.

LATERONASAL PROJECTION — The lateronasal projection is obtained by placing the patient in the same position as for the lateral projection of the facial bones except that the nose is centered to the midpoint of the film. The central ray is directed at a right angle through the bridge of the nose.

Figure 3 shows the three projections. The posteroanterior view (Fig. 3, above left) reveals a fracture at the upper region of the lateral wall of the right maxillary

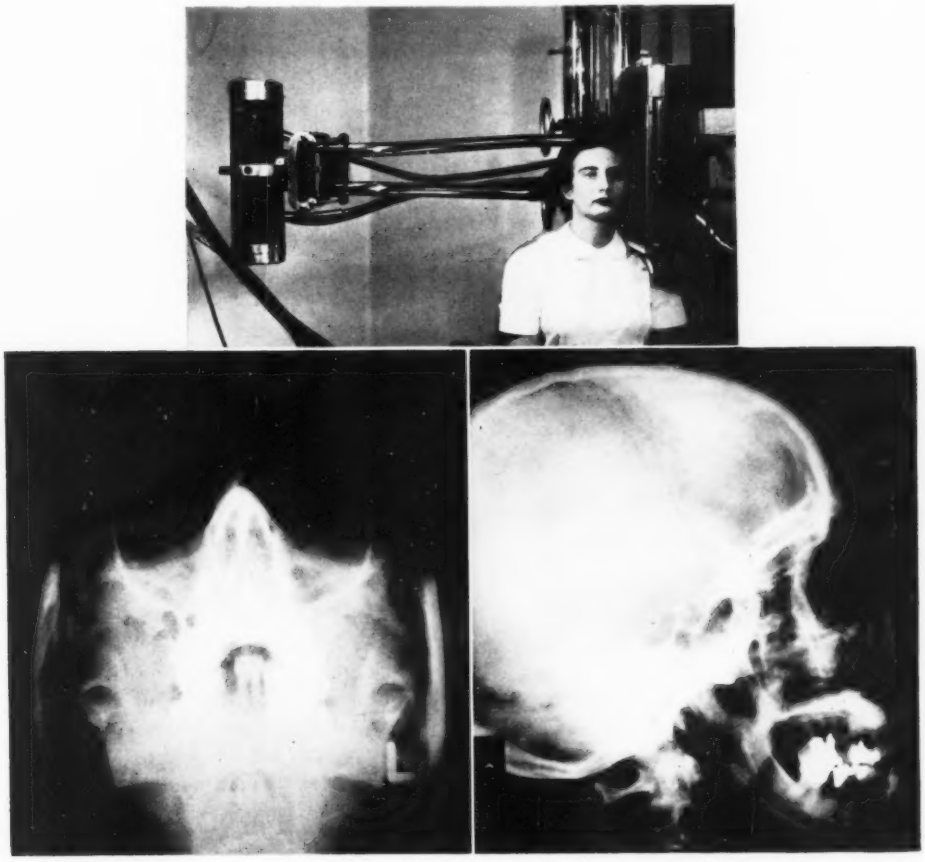

Fig. 2—Above: Lateral projection of facial bones. Below left: Posteroanterior chin-nose projection of maxilla. Below right: Lateral projection

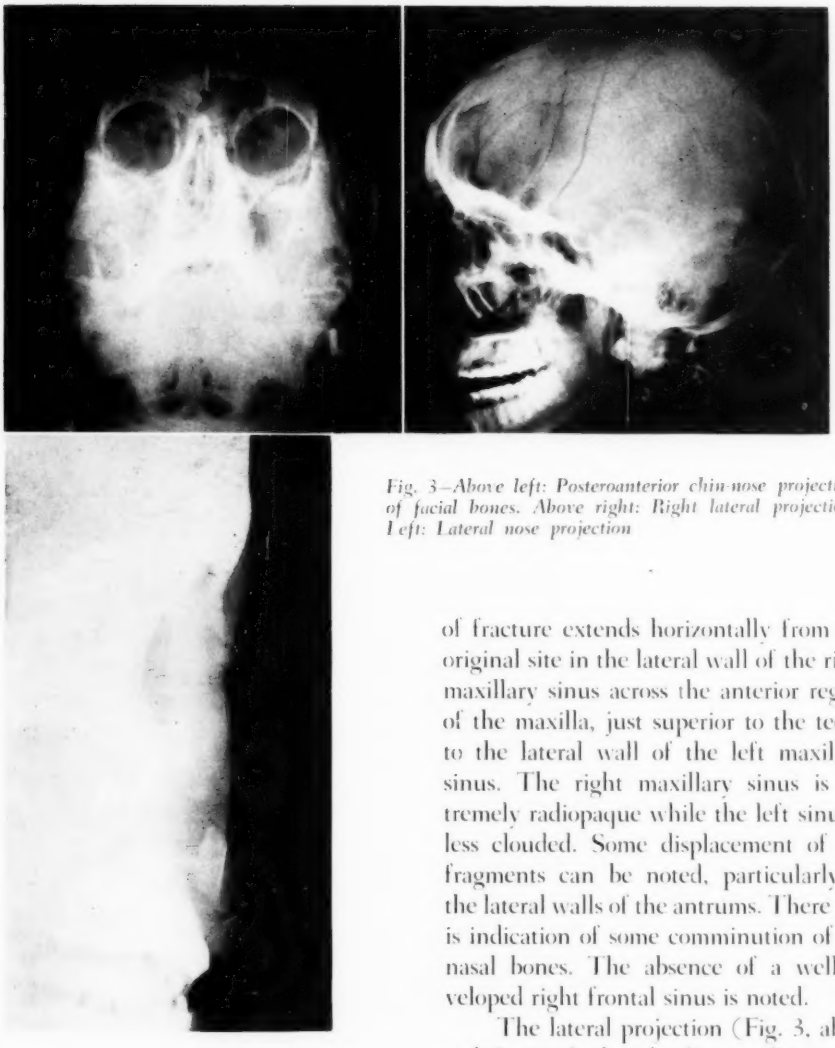

Fig. 3—Above left: Posteroanterior chin-nose projection of facial bones. Above right: Right lateral projection. Left: Lateral nose projection

sinus which apparently follows the zygomaticomaxillary suture obliquely superiorly to the medial third of the infraorbital ridge where there is moderate comminution. It continues upward to the nasofrontal suture which is separated. Another line of fracture extends horizontally from the original site in the lateral wall of the right maxillary sinus across the anterior region of the maxilla, just superior to the teeth, to the lateral wall of the left maxillary sinus. The right maxillary sinus is extremely radiopaque while the left sinus is less clouded. Some displacement of the fragments can be noted, particularly in the lateral walls of the antrums. There also is indication of some comminution of the nasal bones. The absence of a well-developed right frontal sinus is noted.

The lateral projection (Fig. 3, above right) reveals that the fracture line at the nasofrontal region extends posteriorly into the ethmoid region and apparently involves the cribriform plate. Also there is disclosed a line of fracture that extends inferiorly from this region to the deformity in the lateral wall of the left maxillary sinus. The maxilla is seen to be displaced

posteriorly which causes the open bite that can be seen. This is a pyramidal type of fracture that was proved clinically to involve the cribriform plate.

The lateronasal view (Fig. 3, left) leaves something to be desired because the shadow of the soft tissue swelling is superimposed over the nasal bones; however, it does show the comminuted depressed fracture of the nose. Some of the increased density over the upper lip is due to a dressing.

INTRAORAL OCCLUSAL PROJECTION—For the intraoral occlusal view the patient is seated erect and the head is adjusted so that the median plane is vertical and the occlusal plane parallel to the floor (Fig. 4, above). An intraoral occlusal film is placed as far into the mouth as possible with the long axis directed anteroposteriorly and centered to the median plane. The central ray is directed at the midline to a point just above the tip of the nose at an angle of 60 degrees above horizontal. As illustrated, this view can be obtained with the dental x-ray apparatus.

Another occlusal view is made similarly except that the central ray is directed at the canine fossa. If bilateral involvement is suspected, this exposure should be made of each side.

Fig. 4—Above: Maxillary intraoral occlusal projection. Below: Maxillary intraoral occlusal projections

The first projection gives an oblique occlusal view of the anterior region of the hard palate, the anterior teeth and their supporting bone structure. The second gives a similar view of the posterior part of the hard palate, the bicuspids and molars and their supporting bone structure.

These projections are illustrated in Figure 4, below. A line of fracture can be seen superior to the roots of the left second molar (Fig. 4, below left) that extends across the maxilla to the right of the midline (Fig. 4, center) and terminates in the right second molar region (Fig. 4, below right). At the latter area some comminution of the wall of the right maxillary sinus and fracture of the roots of the second molar can be seen. There also is evidence of loss of the central incisors, left lateral incisor and cuspid, with a root fragment in the cuspid socket and a fracture of the root of the left first bicuspid. Apparent carious destruction of the crowns of the upper left molars and partial destruction of the crowns of the upper right first and second bicuspids with periapical bone rarefaction about the latter tooth also can be noted.

■ *Examination of the Mandible*

Basic views for examination of the mandible are as follows:

LATERAL PROJECTIONS—For lateral projections the cassette holder is inclined 30 degrees cranially, or toward the head, and the side being examined is placed toward the film (Fig. 5, above). The shoulder of the opposite side should be depressed so that its shadow will not be projected onto the film.

Body of the Mandible—For views of the body of the mandible the head should be extended over the film to center to the occlusal plane of the teeth at a point midway between the angle and symphysis of the jaw. The surface of the body of the mandible should be parallel with the plane of the film. The central ray is directed horizontally to the centered point. This is illustrated in Figure 5, below left, where the lateral projection reveals a comminuted fracture that extends from the angle of the mandible superiorly to involve the root of the incompletely erupted third molar. A second fracture of the same side appears in the region of the symphysis. This fracture is clearly demonstrated with an intraoral film (Fig. 5, below center). Here the fracture line is seen to be somewhat comminuted and passing between the roots of the lateral incisor and cuspid. There is some separation of the fragments at both sites of fractures but no noticeable displacement. Both the mandibular canal and mental foramen can be visualized.

Ramus of the Mandible—For views of the ramus the head should be positioned so as to place the broad surface of the ramus parallel to the plane of the film. The head is centered to a point just anterior and inferior to the external auditory meatus. An imaginary line from the outer canthus of the eye to the tragus of the ear should be parallel to the transverse axis of the film. The central ray is directed horizontally to the midpoint. A posterior angulation of the central ray of about 5 degrees may eliminate the superimposition of the shadow of the cervical spine which occurs when the head cannot be manipulated satisfactorily.

The lateral projection for the ramus of the mandible is shown in Figure 5, below right. In this instance the body of the mandible from the bicuspid through the molar region is shown in addition to the ramus. The coronoid process is overshadowed by the zygoma, however, and the cervical spine is superimposed on the condyle. The area of greatest importance is shown clearly and a fracture is revealed that extends from the angle superiorly to involve the unerupted third molar. Some superior displacement of the posterior fragment with consequent malalignment of the mandibular canal can be noted.

Symphysis—For the view of the symphysis the head is rotated so that the patient's head rests on the side of the chin with the body of the mandible parallel to the transverse axis, or lower border, of the film. The region of the first bicuspid is centered to the midpoint of the film. The central ray is directed horizontally to this point. Again, a 5 degree anterior angulation of the central ray may show the

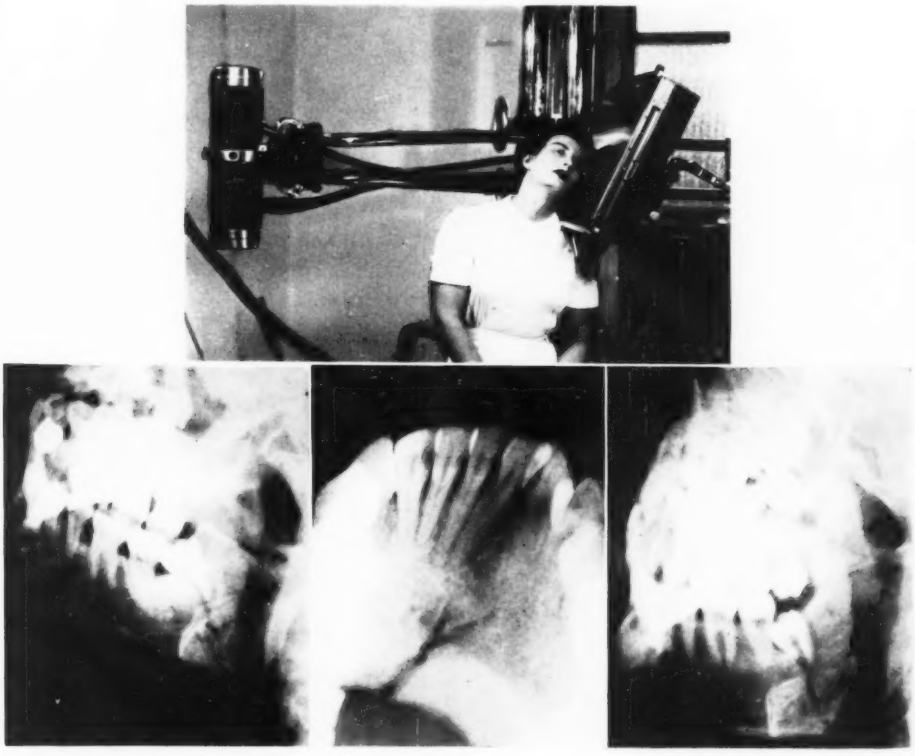

Fig. 5—Above: Lateral projection of mandible. Below left: Right lateral projection of body of mandible. Below center: Oblique inferosuperior projection of symphysis. Below right: Lateral projection for mandibular angle

region more satisfactorily in some instances.

SYMPHYSIS — OBLIQUE SUPEROINFERIOR PROJECTION—For the oblique superoinferior projection of the symphysis the patient is seated in a chair with the head supported (Fig. 6, above). The position of the head is adjusted so that the median plane is vertical and the occlusal plane of the teeth is horizontal. The film is placed under the chin parallel to the occlusal plane with the long axis directed transversely. The midline of the film is centered to the median plane and held in this position by the patient. The central ray is directed at an angle of about 45 degrees above horizontal through a point midway between the vermilion border of the lower lip and the tip of the chin to the midline of the film. This projection is more conveniently made with the dental x-ray apparatus as shown.

Oblique fractures with considerable displacement due to muscle traction frequently are found in the region of the symphysis. Examination by a lateral projection may fail to provide roentgenographic evidence of the fracture (Fig. 6, below left) while the oblique superoin-

Fig. 6—Above: Oblique superoinferior projection—symphysis. Below left: Left lateral projection of symphysis. Below right: Oblique superoinferior projection

ferior view will show the fracture clearly (Fig. 6, below right). In the lateral view the fragments are so superimposed that the fracture is not demonstrated—a simple example of the need for multiple views.

SYMPHYSIS — OBLIQUE INFEROSUPERIOR PROJECTION—For the oblique inferosuperior projection of the symphysis the patient is seated in a chair with the head supported and the chin elevated so that the occlusal plane of the teeth is about 30 degrees above horizontal (Fig. 7). The median plane is vertical. An occlusal film is placed in the mouth as far posteriorly as possible with the long axis directed anteroposteriorly and centered to the median plane. The central ray is directed at an angle of about 20 degrees below horizontal through the tip of the chin to the midline of the film. This projection also gives an oblique view of the symphysis that may reveal a fracture undisclosed in any of the other films of the mandible. It also includes the anterior teeth (Fig. 5, below center).

OBLIQUE ANTEROPOSTERIOR PROJECTION—For the oblique anteroposterior projection the cassette holder is inclined 15 degrees caudally (Fig. 8, above). The occipital region of the head is placed in contact with the cassette holder with the median plane vertical. A point just inferior to a transverse line that passes through the tips of the mastoids is centered to the midpoint of the film. The chin is depressed as far as possible toward the chest. The central ray is directed at an angle of approximately 20 or 25 degrees above horizontal so that it enters at the glabella and passes through the midpoint.

Fig. 7—Oblique inferosuperior projection of symphysis

This projection may be made with the teeth in occlusion or with the mouth open as shown and gives an oblique anterior view of the condyles, coronoid processes, ascending rami and a portion of the body of the mandible. It is especially useful for fractures of the condyloid process in order to determine the position of the superior fragment in the medial or lateral direction.

The oblique anteroposterior view of a mandible is illustrated in Figure 8, below left. It shows considerable medial displacement of the left condyle while the right side is unaffected. The lateral view of the ramus (Fig. 8, below right) reveals an oblique fracture across the base of the condyloid process which extends into the mandibular notch with anterior displacement of the superior fragment.

POSTEROANTERIOR NOSE-FOREHEAD PROJECTION—In the posteroanterior nose-forehead projection the patient faces the vertical Potter-Bucky cassette holder with the nose and forehead in contact with it so that the median plane is vertical and centered over the midline (Fig. 9, above). The upper lip is centered to the midpoint of the film. The central ray is directed

at about 7 degrees above horizontal so that it enters at a point just below the occiput and passes through the upper lip. This affords a posteroanterior view of the body of the mandible as well as the ascending rami. It is used to show any medial or lateral displacement of fragments at the site of the fracture.

When this view is used in combination with lateral exposures (Fig. 9, below), a thorough study of the body of the mandible is possible. Figure 9, below left, shows a lateral displacement of the comminuted fragments that can be seen readily. Excellent comparison can be made between this view and the view of the displacement that is recorded in the lateral projection (Fig. 9, below right).

SUBMENTOVERTICAL PROJECTION—Another projection that is not made routinely but one that is employed frequently to facilitate diagnosis is the submentovertical projection (Fig. 10, above).

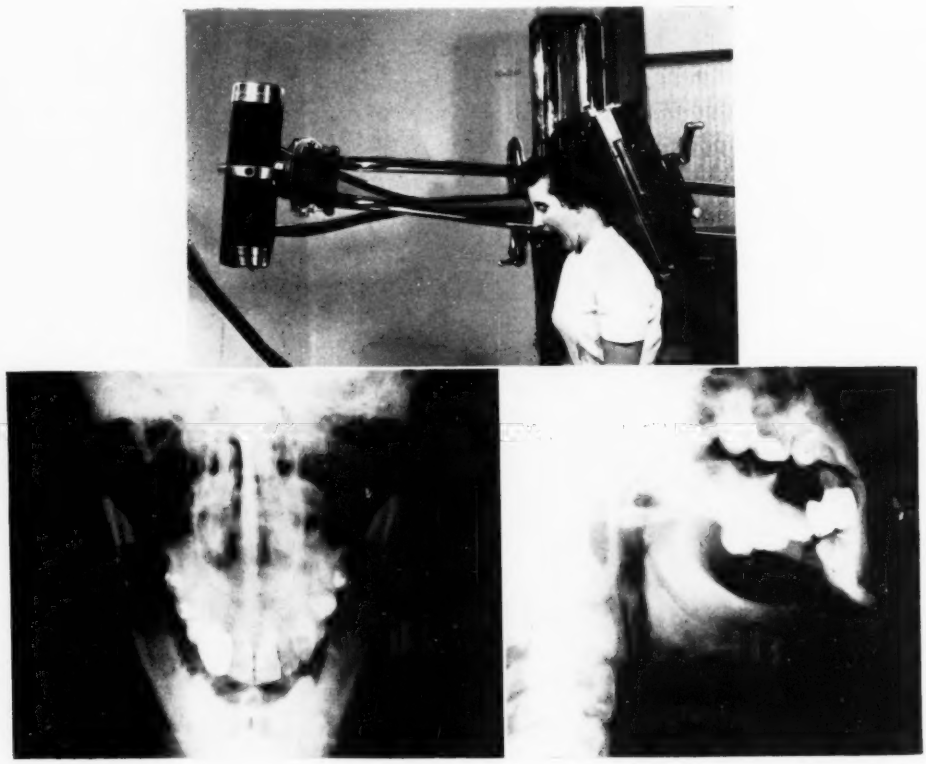

Fig. 8—Above: Oblique anteroposterior projection of mandible. Below left: Oblique anteroposterior of ascending rami. Below right: Lateral projection of left side of mandible

The patient is seated before a vertical Potter-Bucky cassette holder. The chin is fully extended and the vertex of the head rests against the diaphragm. The head is adjusted so that the median plane is vertical and a line passing through the long axis of the zygomatic arch is as close to parallel as possible to the plane of the film. The central ray is directed at a right angle to this line midway between the external acoustic meatuses. This projection gives an inferosuperior study of the body of the mandible and its coronoid and condyloid processes, the zygomatic bones and zygomatic arches as well as the maxillary sinuses and nasal bones.

Figure 10, below, shows unreduced depressed fractures of the left zygomatic bone and anterior portion of the arch. The depressed fragments are seen impinging on the coronoid process of the mandible, thus inhibiting the opening of the mouth.

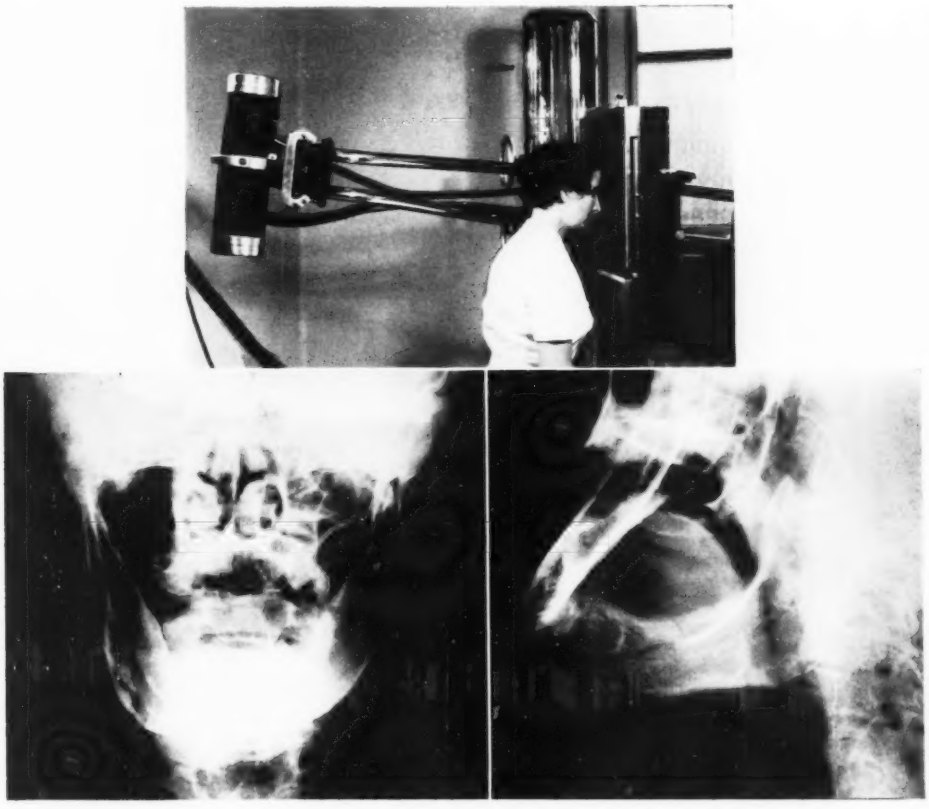

Fig. 9—Above: Posteroanterior nose-forehead projection of mandible. Below left: Posteroanterior projection of body of mandible. Below right: Lateral projection

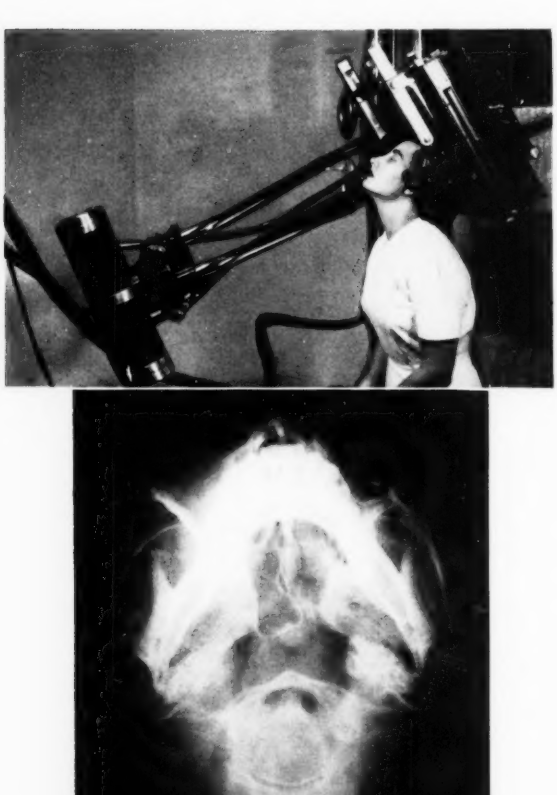

Fig. 10—Submentovertical projections

■ *Comment*

The technics of exposure for the projections described have been omitted purposely. These factors vary so greatly with the type of equipment employed that the individual operator would have no use for such a chart if it were presented here. The importance of the fact that roentgenograms of good quality are necessary for accurate interpretation must not be underestimated, however.

The roentgenographic method of examination is a most valuable asset to the diagnosis of traumatic injuries of the facial bones and jaws. Its full utilization, however, requires roentgenograms in which all structures are visualized as clearly as possible. In this respect, stereoscopic roentgenography provides a valuable

adjunct to interpretation, since it gives the effect of depth and facilitates the identification of the normal as well as the abnormal shadows. The projections described are those most generally employed and usually are sufficient. In some instances additional views may be required for better visualization. There should never be any hesitation in recalling a patient for additional examination so as to determine the extent of injury more accurately. Postoperative roentgenograms should be made routinely to determine the position of the fragments at the site of fracture and to follow the progress of healing.—*10 Peterboro Street.*

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■ The Mature Individual

Fortunate is the individual who can so govern the expression of his instinctive drives as to experience the least conflict in adaptation. Attainment of such adequate self-direction leads to the inner security, the preservation of mental health, and the integrity of personality necessary for wise decisions and ethical conduct. Honesty, courage, facing reality, getting along with others, and doing his job well are indications that a person thinks and acts as a responsible member of society. Moreover, in acquiring these desirable qualities of personality, he has developed the major distinction that marks him as a mature adult; he has progressed from egocentricity to social consciousness—self is subordinated in service to others. The immature individual's attitude toward society is indicated by his goal, as expressed in terms of "What can I get out of it?" The mature individual thinks and acts in terms of "What can I give? What opportunity for service is available?" Habits of thoughtfulness, consideration, kindness, and tolerance have crystallized in the personality and have made self-evident the fact that usefulness brings the greatest satisfaction in life; that happiness is based not upon material things alone, but upon the security of a self-disciplined life motivated by interest in the welfare of one's fellow man.—*F. S. DuBois, M.D., The Security of Discipline. Mental Hygiene, July, 1952.*

Individually constructed stainless steel bone onlay splint for immobilization of proximal fragment in fractures of the angle of the mandible

■ *Arthur E. Smith,* M.D., D.D.S., and Marsh Robinson,† M.D., D.D.S., Los Angeles*

The object of this paper is to present an improved technic for immobilization of fractures at the angle of the mandible. The individually designed and constructed stainless steel bone onlay splint described herein is based on 17 years' research. Three case reports will illustrate its use.

In fractures at the angle of the mandible, the combined action of the muscles of mastication tends to pull the proximal fragment upward and inward. This powerful muscle pull, which may distract the bone ends, has been a serious and complicated problem for the oral surgeon. The number of methods advocated in the past to handle fractures shows that none of them were successful in all instances. In closed reduction there is always the danger that soft tissue, bone, broken teeth or fillings will be interposed in the fracture line. Reduction often is incomplete. Stabilization too frequently is unsuccessful even though intraoral appliances that extend to the proximal fragment, plaster headcap with traction wire, intermedullary pin, or the extraoral Roger Anderson type of appliance are used. An open operation when interosseous wires are used may accomplish an anatomic reduction but it often fails to stabilize the proximal fragment. The use of rigid cast commercial bone plates seldom is satisfactory as they are bulky and cannot be contoured to fit the surface of the bone accurately. The fixing of a poorly fitting rigid bar may in itself cause distraction of the bone ends. As only the screws in a one bar cast plate resist the pull of the muscles, the screws often fail.

Intermaxillary wiring is the method of choice if a usable tooth exists in the proximal fragment or if the fragments are not displaced and the fracture is such that displacement will not result from the pull of the muscles.

■ *Stainless Steel Splint*

The materials needed to construct the stainless steel splint are as follows:

1. Stainless steel (18-8), from 0.027 to 0.030 of an inch in thickness. Since the introduction of Krupp wire in 1926 it has

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been found that 18-8 stainless steel is nontoxic to tissues and can be used successfully within the human body. This alloy is relatively noncorrosive, nonelectrolytic and embodies the austenitic structure. The metal is exceedingly strong and is not brittle. A splint made from this metal can receive its final contouring to the bony surfaces at the time surgery is performed. This gives it a great advantage over cast metal which is brittle and cannot be contoured. Stainless steel (18-8) has the approximate formula percentages: chrome 18, nickel 8, iron 74, carbon 0.1.

2. Special designed stainless steel screws. We are now using a specially designed stainless steel screw which has a thin hexagonal head. The screw is self-tapping. The screws are 0.375 of an inch in length, but a selection of shorter lengths can be made by cutting the screw and reshaping the self-tapping pilot which is 0.075 of an inch in diameter. The outside diameter of the screw is 0.114 of an inch; the body of this precision-made screw is 0.094 of an inch.

3. A dental engine and a special spiral two-bladed precision-made drill 0.094 of an inch in diameter (Fig. 1).

4. Hexagonal socket wrench for the screws.

METHOD OF CONSTRUCTION—A thorough roentgenographic examination (Fig. 2, left) should be made of the angle fracture. A celluloid tracing of each fragment is made, and the tracing is cut to show the desired reduction (Fig. 2, right). From these roentgenograms and tracings the fracture line can be drawn on a model mandible (Fig. 3) of approximately the same size. With a pencil the splint design can be drawn on the dry bone or plaster. The controlling points will be the location of the four screw holes. The screws should be placed far enough away from the fracture line for strength and in such a position that they will not interfere with the inferior alveolar nerve and vessels (Fig. 2, right). The two screws on the lateral surface of the mandible are connected by the tension bar which need not be more than 1/16 of an inch wide. This portion of the splint is subjected to tension because of the pull of the muscles. The vertical screw holes in the inferior surface of the mandible should be placed in good bone in such a way as not to interfere with the screws placed in the lateral surface (Fig. 2, right). These two screws are connected by the U-bar of the splint. This portion of the splint on the inferior surface of the mandible may bend at the point of fracture. For this reason and also because

Fig. 1—Special spiral two-bladed drill 0.094 of an inch in diameter. This precision-made drill allows self-tapping screws to cut into bone with equalized pressure

it allows for better adaptation to the bone, this portion of the splint is fashioned into a U-bar which offers greater resistance to bending. The connecting of the tension bar to the U-bar can be done in various ways: two connectors may be vertical or the connecting members may be from the upper screw holes diagonally down to the lower border of the fracture. In another design a single connector runs from the tension bar to the U-bar at the point of fracture which strengthens the splint at the critical bending point and also makes it easier to adapt.

The design now can be transferred to the sheet of 18-8 stainless steel by means of a sheet wax pattern (Fig. 4, left) or by other suitable means. The splint then is cut from the sheet metal in the flat form (Fig. 4, center), and the holes are drilled to accommodate the screws. The stainless steel splint is then contoured to fit the model mandible (Fig. 4, right) and finished by polishing.

■ *Surgical Application of Stainless Steel Splint*

Intraoral or extraoral deep block anesthesia is the method of choice for the operation. With a dermatograph the fracture is drawn on the skin (Fig. 5, left) from the preoperative roentgenogram (Fig. 5, right). The incision should be approximately 1 cm. below the lower border of the mandible beneath the angle fracture and should be long enough to insure adequate exposure (Fig. 5, center), usually approximately 5 cm. This incision often can be placed in or parallel to a wrinkle. It is made through the skin, subcutaneous tissues, platysma muscle and through the periosteum in the region of the fracture. The fracture line should be well visualized (Fig. 5, center), and all soft tissue and foreign material should be removed from the fracture site. The fracture can be manually reduced to an anatomic position (Fig. 6, left). The previ-

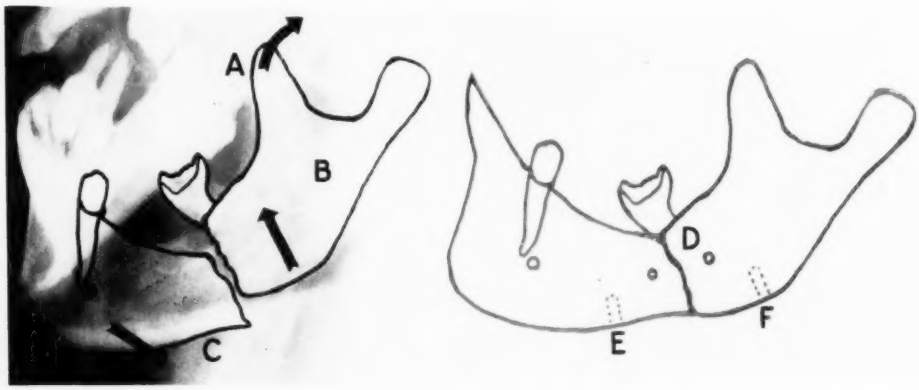

Fig. 2—Left: Outlined roentgenograms showing displaced angle fracture. Arrow at A indicates temporal muscle exerting upward-posterior pull. Arrow at B indicates combined forces of masseter and internal pterygoid muscles exerting upward-anterior pull on proximal fragment. Arrow at C indicates downward pull by the depressor muscles. Right: Tracing of roentgenograms with sections cut and approximated. D indicates lateral holes 1 cm. from fracture line. E and F illustrate holes in lower border of mandible

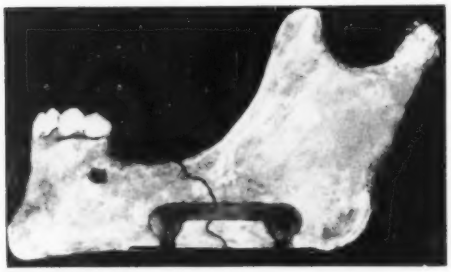

Fig. 3—Wax pattern fitted over a model mandible. This pattern assists the designing of the onlay splint

ously prepared stainless steel splint is then applied to the bone across the fracture site, while the assistant holds the fragments in approximation with Allis forceps. It is important at this time to contour the splint additionally in order to fit the particular mandible. After this is done, the pilot holes are bored in the bone under a constant stream of normal saline solution. One hole is made at a time and the screw placed (Fig. 6, center). Great care should be taken in the drilling of the pilot holes so that the bone will not be devitalized by the heat generated during this procedure.

After the splint has been placed (Fig. 6, right, and 7, left) the deeper tissues are closed with mattress-type small gut sutures. The skin can be approximated in any way favored by the operator. We use a no. 32 stainless steel subcuticular pull-out wire (Fig. 7, center). When possible, intermaxillary wiring should be employed to immobilize the jaws. The postoperative care consists of removing any silk skin sutures before the fourth day and the subcuticular pull-out wire between the tenth and fourteenth day, after which the care is the same as for other fractures where intermaxillary wiring has been used. Postoperative roentgenograms (Fig. 7, right) should be taken.

■ *Case Reports*

CASE 1—A 29 year old, white housewife was first seen May 11, 1951. Two days previously she had slipped from a stepladder in her home and had struck her jaw. She complained of pain in the left side of her mandible. The patient's oral hygiene was poor, a number of carious teeth were present and the major portion of the crowns of several teeth were missing. The crown of the lower left third molar was three-quarters destroyed by caries and this tooth exhibited considerable mobility and tenderness. The fracture was clinically visible mesial to this tooth. Roentgenographic examination revealed an angle fracture of the left side of the mandible along the mesial surface of an anteriorly drifted third molar. The fragments were displaced approximately 5 mm. with the proximal fragment upward and medial. There was a rarefied area approximately 3 mm. in diameter in the alveolar bone on the distal fragment in the fracture line which suggested a chronic dental alveolar infection.

The diagnosis was open, left mandibular angle fracture, moderately displaced, with acute exacerbation of chronic dental alveolar abscess of the lower left third

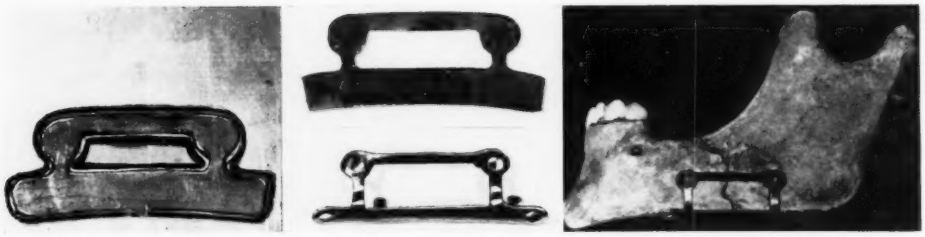

Fig. 4—Left: Wax pattern placed on stainless steel plate. Margins outlined for cutting metal. Center: Rough model cut out of metal; finished metal onlay splint. Right: Onlay splint fitted over model mandible for additional shaping

molar tooth which was in the line of fracture.

On May 22, under a general anesthetic, an open reduction and immobilization of the mandibular fracture by a stainless steel splint was done (Fig. 5 to 7). The third molar was removed from the soft tissue. A fifth screw was placed beneath the tension bar in the proximal fragment to furnish added resistance to the muscle forces. The patient had chronic dental alveolar abscesses which involved the maxillary second and third molar teeth and the maxillary second bicuspid on the left side. Because of these infected teeth the jaws were not immobilized by intermaxillary wires.

Although it is not our policy to remove teeth in the line of fracture if they can be used even temporarily for immobilization of a fracture, in this instance the teeth could not be used for intermaxillary wiring.

CASE 2—A 31 year old white man was injured in an automobile accident near Deming, N. Mex., on June 13, 1951. Roentgenograms taken at a local hospital (Fig. 8, left) revealed an angle fracture of the right side of the mandible and a

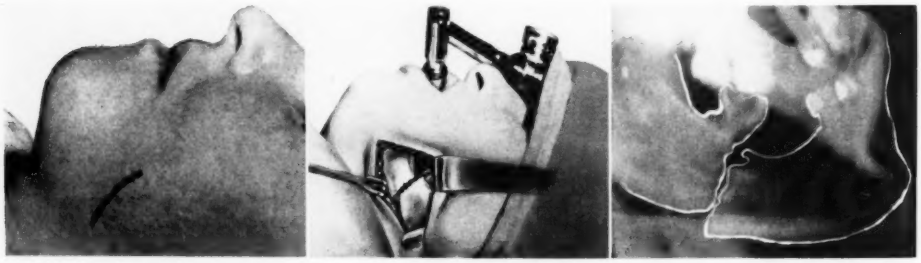

Fig. 5—Left: Case 1, May 22, 1951, at time of surgery. Fracture is drawn on skin with dermatograph. Center: Open fracture at angle exposed. Note third molar, which was abscessed and loose, in fracture line and elevation of proximal fragment. Right: Preoperative roentgenogram, Case 1. Note displacement of fragments

condylar fracture on the left. Arch bars with elastic traction were placed to immobilize the jaws. At that time the angle fracture on the right side was not displaced. On June 17 the patient was transferred by air-ambulance to St. Vincent's Hospital, Los Angeles. Roentgenograms taken June 18 showed a left condylar fracture without displacement. The angle fracture on the right side (Fig. 8, center) extended along the distal surface of an unerupted third molar tooth. Because of muscle pull the proximal fragment had now been displaced approximately 6 mm. upward and approximately 5 mm. anteriorly. It overrode the distal fragment which had been fixed elsewhere by the arch bars. On June 22, under a general anesthetic, the angle fracture on the right side was reduced and immobilized (Fig. 8, right). At the time of surgery (Fig. 9, left) it was found that the posterior fragment was pulled upward 1.5 cm. The inferior alveolar vessels and nerve had been severed at the time of the accident. The impacted third molar was removed through the extraoral incision. It was found to be loose and attached to a small separate fragment of buccal bone. No screw was placed in the posterior hole

Fig. 6—Left: Fractured fragments being approximated. Two Allis forceps usually are used. Center: Placement of fourth screw. Right: Case 1. Displaced angle fracture reduced. Third molar has been removed as it could not be used even temporarily for stabilization

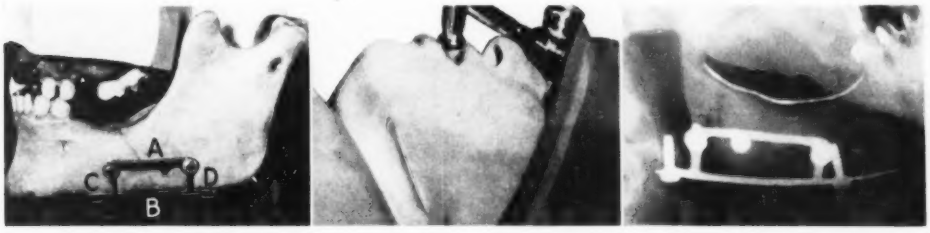

Fig. 7—Left: Model made from impressions of patient's upper and lower arches (Case 1). Note form-fitting onlay splint. Upper tension bar indicated at A prevents separation of fragments; form-fitting U-bar at lower border B resists bending at fracture point. C and D are the vertical connecting bars. Center: Tissues involved in surgical approach approximated with fine subcuticular stainless steel pull-out wire. Note accuracy of approximation which leaves only a fine line scar. Right: Roentgenogram of Case 1, taken three months postoperatively, shows adequate stabilization of bone fragments by means of onlay splint

Fig. 8—Left: Case 2. Posteroanterior roentgenogram taken June 13, 1951. Note proximal fragment, although separated, is not displaced superiorly and medially at this time. Center: Right lateral roentgenogram taken June 18. Note depressed anterior fragment and elevated posterior fragment. Right: Photograph taken June 22. Curved line drawn on skin indicates position of open angle fracture on right side

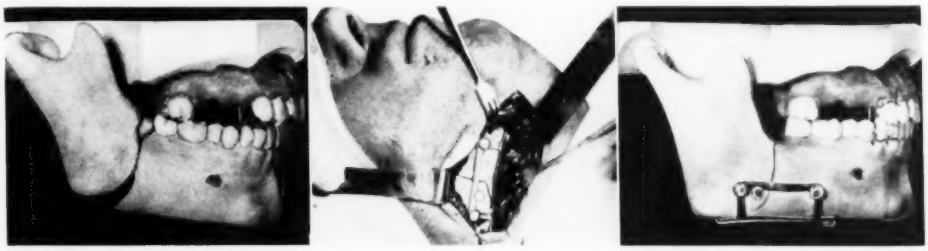

Fig. 9—Left: Case 2. Model of patient's upper and lower arches showing displacement of angle fracture at time of surgery. Center: Open fracture at angle of mandible reduced. Note accurate approximation of bone fragments and form-fitting onlay splint. Right: Model illustrating individually constructed stainless steel onlay splint immobilizing proximal fragment

beneath the mandible since the bone in this region was too thin (Fig. 9, center). The fourth screw therefore was placed under the tension bar in the posterior fragment to aid further in overcoming the pull of the muscle (Fig. 9, right). The wound was closed in the usual manner (Fig. 10, left) and the patient made an uneventful recovery. After six weeks postoperative roentgenograms (Fig. 10, right) showed good healing.

This case illustrates that the distraction of angle fractures may not be apparent immediately. In Case 2 roentgenograms taken the day of the accident showed no anterior medial displacement of the proximal fragment. Five days later, on admission to the hospital in Los Angeles, roentgenograms disclosed the proximal fragment had moved upward and medially approximately 0.5 cm (Fig. 8, center). Ten days after the injury, at the time of surgery, it was found the proximal fragment was displaced approximately 1.5 cm. anteriorly and medially (Fig. 9, left). During this period of gradual displacement caused by the pull of the muscles, the jaws were adequately immobilized with arch bars and rubber bands. This case emphasizes the necessity of repeating the roentgenographic examination of angle fractures which have been treated with

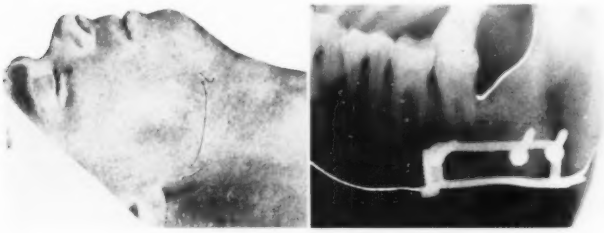

Fig. 10—Case 2. Surgery completed. Note hairline approximation of flaps by means of fine stainless steel wire. Right: Lateral roentgenogram of angle fracture on right side taken in September 1951

intermaxillary fixation. In angle fractures, the first roentgenograms should not be considered proof that the case can be treated successfully by intermaxillary fixation alone.

CASE 3—A 59 year old white man (Fig. 11, left) had received a blow which caused a compound fracture of the angle at the left side of the mandible two months prior to reduction and immobilization. The patient had been edentulous for many years and was wearing satisfactory dentures until the time of injury. In the two months before the fracture was reduced the patient was unable to wear his dentures because of the deformity in the lower left side of the jaw. Preoperative roentgenograms (Fig. 11, right) taken December 26, 1940, revealed an oblique fracture at the angle of the left side of the mandible. The fracture was displaced with the proximal fragment overriding approximately 1 cm. above and medial to the distal fragment. Under local anesthesia, the patient was operated on January 3, 1941, at which time it was necessary to dissect the fibrous tissue found about the ends of the fragments so that the proximal fragment could be drawn downward and backward into a normal position. The splint (Fig. 12, left) consisted of one lateral tension member approximately 3 cm. in length. From this portion extended two tentacles approximately 1.5 cm. in length which were adapted beneath the lower border of the mandible. Two screws were employed. For additional stabilization, no. 26 stainless steel wires were looped over the end of the proximal fragment (Fig. 12, left) and fixed to the splint. The patient made a satisfactory recovery (Fig. 12, right, and 13). His dentures required relining. His condition was followed for 1½ years at which time he died of a heart attack.

This case illustrates a delayed reduction in an edentulous mandible two

Fig. 11—Left: Case 3. Photograph taken December 26, 1940, two months after injury, showing partially healed angle fracture, left side of mandible. Note elevation of proximal fragment. Right: Preoperative roentgenograms showing angle fracture of left side of mandible. Note overriding and elevation of proximal fragment

Fig. 12—Left: Case 3. Postoperative intraoral and extraoral roentgenograms taken April 14, 1941, showing reduction and immobilization by means of individually constructed onlay splint. Right: Postoperative photograph. Note smoothness of lower left arch

Fig. 13—Left: Postoperative view. Note hairline scar visible below angle on left side of mandible. Right: Postoperative appearance. Note normal intermaxillary relation, normal facial tissue relation and expression. Left lateral mandibular deviation was prevented by accurate immobilization of proximal fragment

months after an angle fracture which was grossly displaced. In this case one of the early designs for the splint which lacked the U-bar effect at the lower border was used. If the newer splint design had been used, the two wires would not have been necessary.

■ *Comment*

This improved method of individually designing and constructing a stainless steel splint insures adequate immobilization of the proximal fragment in angle fractures and allows them to heal in a normal relation. The metal used in this splint is relatively nonelectrolytic, nonmagnetic, noncorrosive, nontoxic and causes negligible tissue reaction. It seldom is necessary to remove the splint. By an open type of operation it is possible to effect an anatomic reduction of the fracture. Many of the dangers involved in former procedures are greatly reduced or eliminated entirely; these dangers include nonunion, healing in malposition, the interposing of tissue and foreign material at the fracture site, a stormy postoperative course, injury to the inferior alveolar nerve, future prosthetic problems and malocclusion with lateral deviation. If this splint is used, the patient is able to return to work earlier. The small scar is hidden by the contour of the jaw and is not objectionable. The time required for surgery for this procedure is no longer or is less than that required when other methods are used. The patient is more comfortable since unsanitary, irritating, intraoral appliances, a plaster head cap or protruding extraoral pin fixation appliances are eliminated.

Oral surgeons can design and construct this onlay splint which will adequately immobilize the proximal fragment in angle fractures of the mandible.—*511 Wilshire Medical Building.*

The status of oral surgery

THE RECENT NEGOTIATIONS between the American Dental Association and the American Medical Association regarding the limiting of oral surgery services by dental specialists in hospital practice, although productive of some concern, have been in reality a healthy development. Such an exchange of ideas and attitudes has provided an opportunity to develop additional respect for the specialty of oral surgery and to bring about a better understanding of the present background of dentists preparing to practice oral surgery as a specialty of dentistry. It has also brought about a more active realization of the important role this dental specialty occupies in the over-all picture of total health care.

Throughout the period of study and negotiation, it has been the opinion of the special American Dental Association Committee appointed to study this particular problem, that the action taken by the House of Delegates of the American Medical Association[1] did not truly represent the opinions and judgment of the informed medical profession. Instead, there has been good evidence to indicate that the action has been promoted by minor factions that are attempting to limit the oral surgeon in his hospital work to such an extent that the field could easily be usurped by a medical specialty group. Such unilateral action could not be condoned. The Committee has, therefore, set forth specific statements outlining the traditional definition and scope of oral surgery[2] in an attempt to acquaint everyone in medicine with these facts and to make dentistry's position in the matter crystal clear.

Most fields of specialization have been developed through advanced study in an area that is outlined by natural anatomical and physiological boundaries. The well-accepted surgical specialty fields of obstetrics and gynecology, neurosurgery, orthopedics, urology, ophthalmology and otolaryngology have all been developed in this fashion. In each instance, the anatomical or physiological boundaries are well recognized, although a definite line of demarcation cannot always be determined. A similar situation exists in oral surgery, for the field has very clear anatomical and physiological boundaries which simply include the structures that make up or contribute directly to the masticatory organ

system. Since the tongue, teeth, mandible, maxilla, zygoma, salivary glands, lips, cheeks, and palate are all an integral part of this functioning unit, their diseases, injuries, and malformations are within the field of oral surgery, while the ears, tonsils, pharynx, and so on, although closely associated, are not. In spite of the proximity of the latter, they are universally conceded by oral surgeons to be in the field of otolaryngology and are treated thus.

Although some oral surgeons, like men in other specialties, do not choose to cover the entire field of oral surgery, it does not alter the importance of retaining the field as a unit. Individual capabilities or shortcomings are best recognized either by a national board examination or at the local level, so that in either circumstance the public is best served and protected. To limit the field in such a way that the efforts of oral surgeons are rendered ineffectual would indeed be a disservice to the public.

Recent decisions,[3] however, indicate that more representative forces in medicine are influencing the thinking on this important problem, so that an amicable settlement can be hoped for. The American Dental Association fortunately is guided by leaders who can visualize the future horizons of graduate education, and who are capable of helping oral surgeons preserve and build a specialty that will bear the recognition and blessings of both professions. Dentistry and medicine have enjoyed cordial relations in the past, and it is hoped that the present controversy will not in any way retard them in the future.

1. Supplementary report of Board of Trustees concerning the resolution on definition of medical and dental services. J.A.M.A. 152:731 June 20, 1953.
2. News of dentistry. J.A.D.A. 46:88 Jan. 1953.
3. News of dentistry. J.A.D.A. 48:88 Jan. 1954.

Management of facial fractures first of a series of special issues

THE CURRENT ISSUE of the JOURNAL OF ORAL SURGERY is the first of a series to be devoted to a single subject that is of paramount interest and importance in the field of oral surgery. In this issue the clinical aspects of fractures are fully covered. Thus the reader is provided with a complete summary of current practice from roentgenographic and clinical examination through the final and varied details of treatment. It is hoped that other important subjects can be taken up in this way and in sufficient detail so that each issue will provide a modern summary of the topic in question.

The reader will note that considerable emphasis has been placed on the desirability

of open reduction of certain types of fractures, although each author has made it plain that simple intraoral reduction and fixation is still the preferable method of treatment when it can produce the desired results. Many other interesting facets of the management of facial fractures are covered in such a fashion as to insure a maximum of interesting and valuable reading.

The Editorial Board is appreciative of the efforts put forth by all of the authors to produce what is, in our opinion, an excellent series of scientific articles. Dr. Thoma's willingness to take time away from his duties as editor of *Oral Surgery, Oral Medicine, and Oral Pathology* to write a valuable and timely article for the JOURNAL OF ORAL SURGERY is especially appreciated.

It is the sincere hope of the editors that issues such as this will be a valuable contribution to current practice and will be instrumental in promoting progress in oral surgery. —*Fred A. Henny.*

Announcements

■ Lloyd Rogers Elected Chief of Detroit Hospital

For the first time in the history of the Detroit Receiving Hospital, a dentist, Lloyd Rogers, has been elected president of the Hospital. Dr. Rogers has been on the hospital staff for 34 years. He was graduated from the University of Michigan School of Dentistry in 1911 and is a member of the subcommittee on civil defense of the A.D.A. Council on Federal Dental Services.

Dr. Rogers' appointment to head a municipally-owned, general hospital is unique in the annals of American hospital administration; rarely has a dentist been appointed to the chief post of any hospital.

■ Society of Oral Surgeons Changes Meeting Place

The next annual session of the American Society of Oral Surgeons will be held in the Hollywood Beach Hotel, Hollywood, Fla., November 3-6, during the week preceding the 95th annual session of the American Dental Association. The change in meeting place was announced by Don H. Bellinger of Saginaw, Mich., Society president.

■ Board of Oral Surgery Sets Examination Date

May 8-10 are the dates set by the American Board of Oral Surgery for its next certification examination, which will be held at the Blackstone Hotel, Chicago.

Candidates are advised to address L. M. FitzGerald, secretary-treasurer, American Board of Oral Surgery, 718 Roshek Building, Dubuque, Iowa.

■ Board of Dental Specialties Announces New Officers

William A. Jordan of the Minnesota Department of Health was elected president of the Advisory Board for Dental Specialties at its recent meeting in Cleveland. He succeeds Leslie M. FitzGerald of Dubuque, Iowa. Capt. A. H. Grunewald, DC, USN, of the U. S. Naval Hospital, Great Lakes, Ill., was re-elected secretary-treasurer of the Board.

Composed of representatives of all recognized specialty boards, the Advisory Board works with the Council on Dental Education, as well as with the American Association of Dental Schools and the American Association of Dental Examiners.

■ American Dental Association to Meet November 8-11; Council on Scientific Session Announces Program Subjects

The American Dental Association will hold its 95th annual session November 8-11 in Miami, Fla. The Board of Trustees and the House of Delegates will meet simultaneously with the scientific program to conduct official business meetings and elections.

Four subjects will be featured on the scientific program, reports the Council on Scientific Session. These are (1) the role of sugar as a factor in dental caries, (2) the use of newer devices for cutting tooth structure, (3) uses of elastic impression materials, and (4) the hazards of the roentgen ray in dental practice. Speakers and details of the program will be announced later.

■ Hospital Group Liberalizes Dental Staff Rules

Oral surgeons may admit and discharge oral patients in hospitals approved by the Joint Commission on Accreditation of Hospitals, according to a recent interpretation of the Dental Staff Standard which was approved by the Joint Commission December 5.

The Dental Staff Standard reads in part, "Patients admitted for dental services shall be admitted on a surgical service." The interpretation as published in the Joint Commission's December 1953 *Bulletin* says that a surgical service "may be the oral surgical service to which the members of the dental staff admit and discharge dental patients." It also provides that "the staff of the hospital would be a 'medical and dental staff' and that . . . dentists would be appointed to and hold appointments in the division of oral surgery just as physicians and surgeons are appointed to other services of the hospital."

The new interpretation was the result of a conference between the Commission and representatives of the American Dental Association's Special Committee on Problems in the Field of Oral Surgery and the Council on Hospital Dental Service. Chairman of the Special Committee is Leslie M. FitzGerald, president of the Association; chairman of the Council is Frank Hower of Louisville, Ky.

■ Berkshire Conference in Periodontology and Oral Pathology to Meet June 20-24

A special feature of Tufts College Dental School's Berkshire Conference in Periodontology and Oral Pathology scheduled for June 20-24 at Falmouth, Mass., will be a clinico-pathological seminar with microscopes provided for all participants. The Conference is sponsored by the Dental School's division of graduate and postgraduate studies.

The program will consist of four days of lectures, seminars and panel discussions on clinical problems in dentistry, medicine and their related fields.

The faculty of the conference includes Irving Glickman, Hamilton B. G. Robinson, Col. Joseph Bernier, Harry H. Shapiro, Robert E. Moyers, Joseph S. Landa, Don Bellinger and David Weisberger.

Mornings and evenings are to be devoted to professional activities, leaving afternoons free for recreation. Further information may be obtained by writing to The Fifth Berkshire Conference, Tufts College Dental School, 136 Harrison Avenue, Boston 11.

■ Graduate Instruction in Oral Surgery to Begin in the Fall at the University of North Carolina

Graduate instruction in oral surgery at the University of North Carolina School of Dentistry will begin in the fall semester of 1954. The course will lead toward a Master's Degree or a certificate from the Graduate School. The curriculum is designed to prepare dentists for the specialty practice of oral surgery, and requires a residency of two academic years and two summer sessions.

Clinical and laboratory facilities of the School of Dentistry, the North Carolina Memorial Hospital (600 beds) and Gravely Sanatorium (100 beds) are available to graduate students. The basic sciences will be taught in the several departments of the School of Medicine.

Further information may be obtained from the Office of the Dean, School of Dentistry, University of North Carolina, Chapel Hill, N. C.

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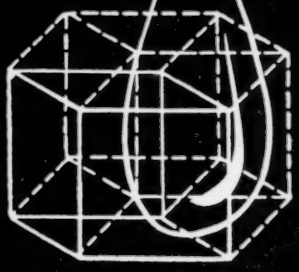

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† *Bragdon, C.: A Primer of Higher Space, New York, Alfred A. Knopf, 1923, Pate 1.*

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Hingson, R.A., N.Y. J. Dent., 30:370 (Oct.) 1950.

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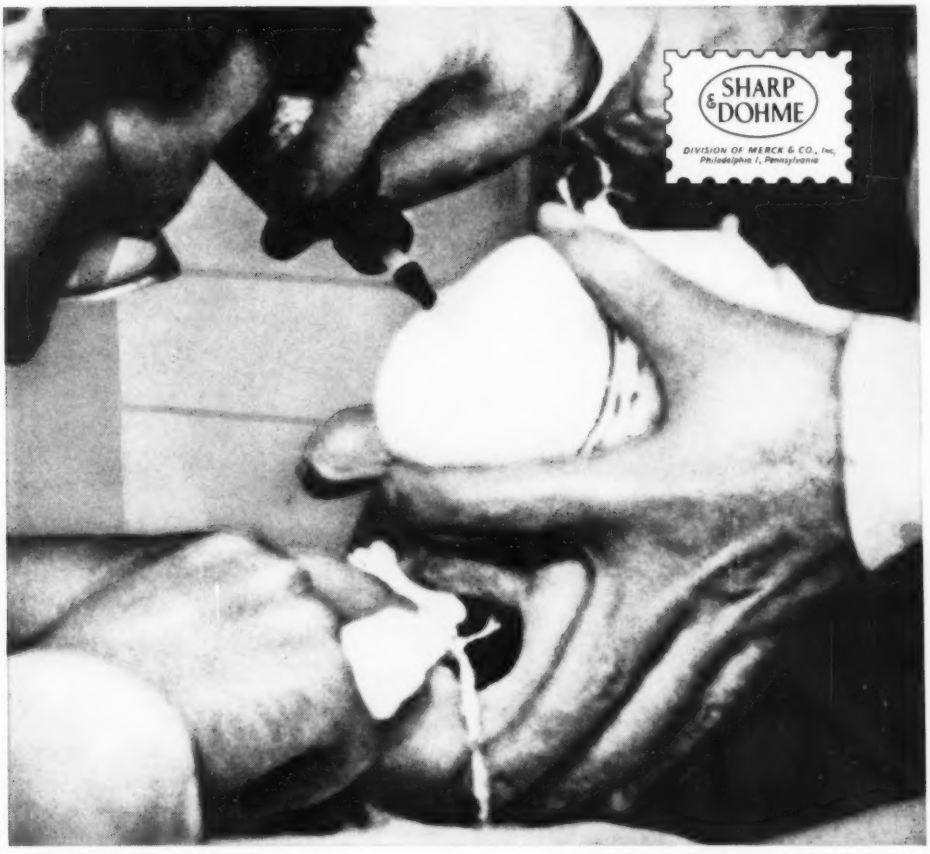

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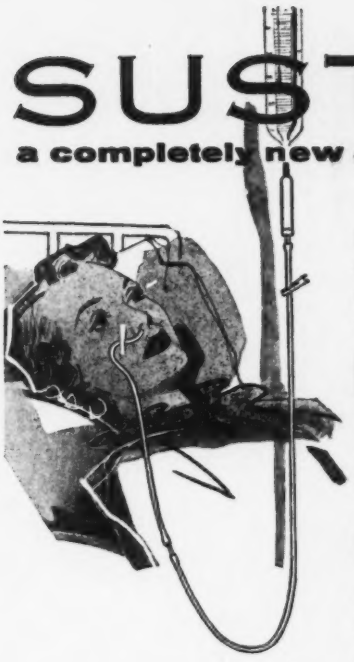

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